CALIFORNIA
OIL WORLD
and Petroleum Industry

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Crum-Brainard

INDIVIDUALIZED BIT SERVICE FOR YOUR SPECIFIC FIELD CONDITIONS

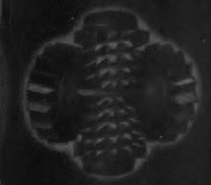
★ With time and equipment at a premium today, it is of vital importance that you get every foot of hole possible from every bit you run. But because no two formations drill exactly alike — regardless of geological similarity — standard bits frequently cannot meet special field conditions, boosting costs unnecessarily high.

NOW, Crum-Brainard *individualized* bit service enables you to efficiently meet *any* field problem with a bit that exactly fits your requirements! Besides the 7 basic types shown here for the general formations listed, Crum-Brainard will change the shape or number of teeth, or redesign angle and pitch of cutters to conform to your specifications.*

Send us a description of the formations in your field and your suggestions as to rock bit characteristics needed to drill them efficiently. Our engineers will be glad to incorporate these suggestions in perfecting a bit for *your specific needs*, or in recommending one or more standard Crum-Brainard types for your conditions.

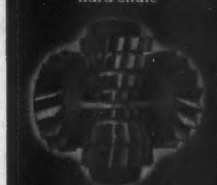
*In numerous competitive runs all over the world, Crum-Brainard Bits, properly selected for local conditions, have out-performed all other types!

Type "OSS" for soft, sticky formations

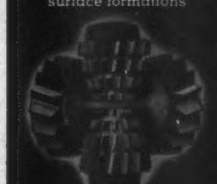


Type "OS" for shale and medium sand rock

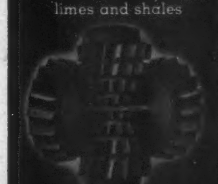
Type "OW" for medium hard shale



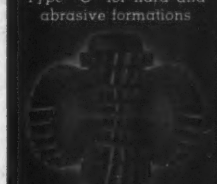
Type "O" for ordinary surface formations



Type "CO" for abrasive limes and shales



Type "C" for hard and abrasive formations



Type "CF" for extremely hard formations

Crum-Brainard

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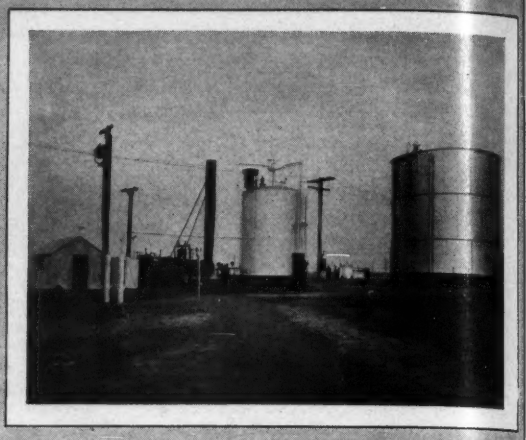
BRANCH WAREHOUSES

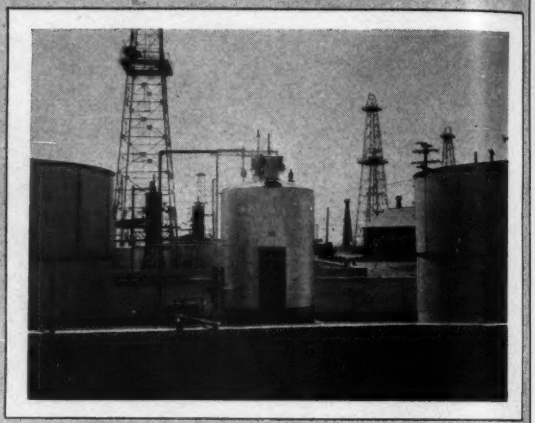
PETROLEUM SERVICE CO., SANTA MARIA, CALIF. ★ VALLEY WAREHOUSE, BAKERSFIELD, CALIF. ★ B & G SERVICE CO., AVENAL, CALIF.

Vol. 35 No. 7 Whole No. 1606

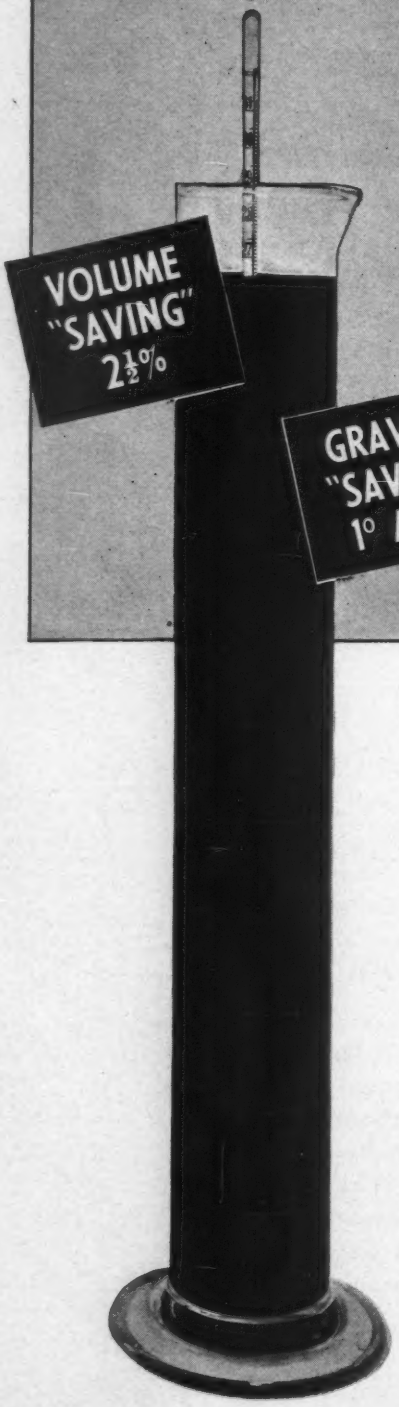
Save GRAVITY *and* VOLUME --- *for* DEFENSE



Petreco saves 1° A.P.I. gravity on this lease.



Petreco conserves 2% volume loss for this producer.



Laboratory tests indicate that average crudes ranging from 20 to 30° A.P.I. show a saving of 2½% in volume for every 1° A.P.I. saving in gravity.

The loss of gravity and volume in conditioning crude oil for shipment has been recognized always as poor production practice . . . now, with victory dependent on the performance of motorized equipment, petroleum conservation is absolutely essential.

Petreco's vapor-tight electric dehydrating process enables the oil producer to condition his crude economically, and at the same time conserve the volatile fractions, often the most valuable portion of the crude. It is in the conservation of the volatiles . . . the light ends . . . that Petreco maintains true gravities and prevents volume losses.

The Petreco organization, active in production areas everywhere, for many years has specialized in the dehydration and handling of crude oils. Conservation and efficiency have always been important, but this importance is doubled today. NOW is the opportune time for a survey of possible volume and gravity losses . . . Petreco engineers are at your service for this work.

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April 10, 1942

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LANE-WELLS *Everywhere*

"Physical Constants of Low Boiling Point Hydrocarbons and Miscellaneous Compounds"

By Robert Matteson* and W. S. Hanna*

(Presented by D. B. Johns, Standard Oil Co. of Calif. at C.N.G.A. April 10 meeting.)

During the past ten years a number of useful compilations (1,2,3,4, 5,6) (7) of physical constants, ranging from the California Natural Gasoline Association's concise tabulation to the exhaustive volumes by Egloff, have been published. None of these, however, serves as a compact table suitable for notebook use by the engineer or research technologist in the petroleum and allied industries. To fill this need a table of the physical constants of a number of hydrocarbons, principally in the gasoline boiling range, and certain miscellaneous compounds of interest in the petroleum and natural gas industries has been prepared. The tabulation of constants is given here as Table I, and the bibliography of references from which the basic constants were derived is contained in Table II.

Table I is made up of the fundamental constants representing experimental data reported in the literature and calculated constants all converted to English units in order to be of maximum utility in engineering computations.

Discussion of Individual Constants:

1. Molecular Weight

Molecular weights are based upon the 1941 International Atomic Weights.

2. Carbon-Hydrogen Ratio

This constant is the ratio of the weight of carbon to the weight of hydrogen in the hydrocarbon molecules.

3. Melting Points, Boiling Points, Critical Constants, and Liquid Density in Grams per Milliliter

The values in Table I are based upon data given in the sources noted in Table II. The liquid densities shown for methane, ethane, ethene, and propene are the best available approximations. Those for propane, the butanes, and the butenes are observed values of the density of the liquids under their respective vapor pressures at 60°F. instead of 760 m.m. as shown in the column heading. The small effect of compressibility of the liquid is entirely negligible for engineering computations.

4. A.P.I. Gravity and Pounds per Gallon, etc.

Liquid densities were converted to A.P.I. gravities and pounds per gallon by means of the tables or formula given in the National Bureau of Standards Circular C-410, issued March 4, 1936. Gram mols per milliliter and pound mols per 100 gallons were calculated from the above-mentioned constants.

5. Gas Densities

The specific gravity of the gases was calculated on the basis of air= 1.00 and the molecular weight of air =28.966.

$$\text{Sp. gr.} = \frac{\text{M. W. gas}}{28.966}$$

The number of pounds per 100 cubic feet of vapor was calculated on a perfect gas basis as follows:

$$\text{Lbs./MCF} = 1000 \times \text{M.W.} \times \frac{28.316}{453.592} \times \frac{492}{520} \times \frac{1}{22.414}$$

The cubic feet of gas equivalent to a gallon of vaporized liquid was calculated from the relations:

$$\frac{1}{1000} \quad \frac{\text{Pounds}}{\text{Gallon}} \quad \frac{1}{\frac{\text{Pounds}}{\text{MCF}}}$$

A column of values is also given showing the "actual" volume of gas at 60°F and 760 mm. formed upon vaporization of a gallon of liquid. These values are obtained by dividing the perfect gas values by the gas law deviation factor.

The unit volume of gas per unit volume of liquid was obtained from the relation.

$$\frac{V_{gas}}{V_{liq.}} = \frac{\text{Cubic feet of gas}}{\text{Gallon}} \times 7.481$$

6. Gas Law Deviation Factor

This factor is defined by the equation:

$$Y = \frac{nRT}{PV} \qquad (n = 1.0)$$

where "Y" is the factor indicating the degree of departure from the perfect gas laws, and is equal to 1.000 at zero pressure.

7. Specific Heats and Ratios of Specific Heats

Values were taken from the sources noted in the bibliography. The units for specific heats are either Btu's per pound or calories per gram. The ratios, of course, are dimensionless.

8. Heats of Combustion

The values in Table I are based principally upon the work of Rossini and his co-workers. All data published as units of energy per mol were converted to the 1941 molecular weights before expressing the calorific value in the English system of units.

9. Heats of Vaporization and Fusion

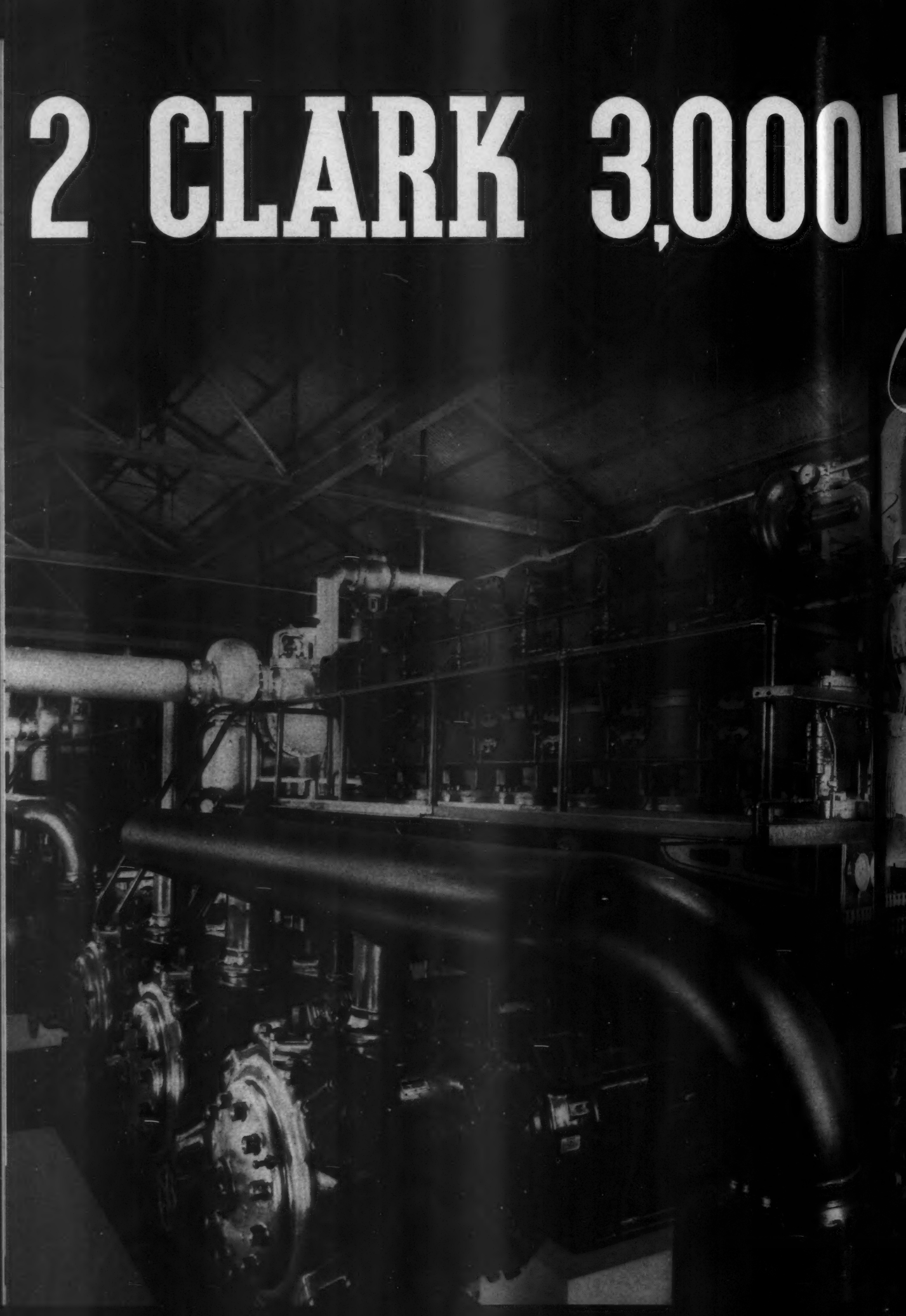
Quantities were taken from the sources noted in the bibliography.

10. Air Required for Combustion

Data under this heading were calculated on a perfect gas basis em-

* Research & Development Department, Standard Oil Company of California.

2 CLARK 3,000 H



0 H.P. Steam "Angles"

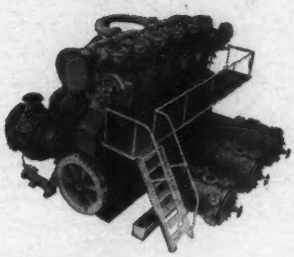
AND 3-1000 H. P. GAS-DRIVEN "ANGLES" IN THE UNION OIL COMPANY REFINERY

at Oleum, California . . . are serving in two important ways in making Hi Octane gasoline.

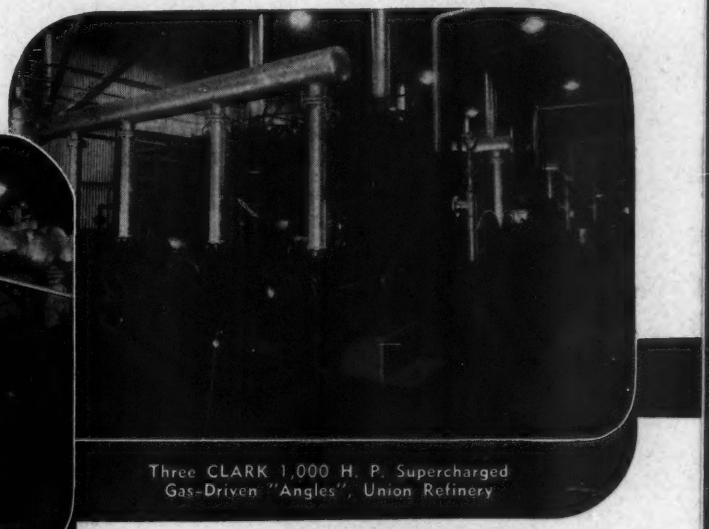
Low quality gasolines are being converted into Hi Octane gasoline by catalytic cracking. The 2 CLARK 3,000 H. P. steam-driven "Angles" furnish compressed air to burn coke, tar and asphalt from the catalyst, keeping it in efficient operation. A gas residue is then compressed by the 3 CLARK 1000 H. P. Supercharged gas-driven "Angles" to recover 8 to 15 additional gallons of highest grade gasoline per 1000 cu. ft. of residue gas.

In defense production, CLARK "Angles" are also being used for Alkylation, another new cheap method for making 100 Octane gasoline, and for producing Toluol for TNT, Artificial Rubber, Synthetic Alcohol, Synthetic Ammonia for explosives, and other important products.

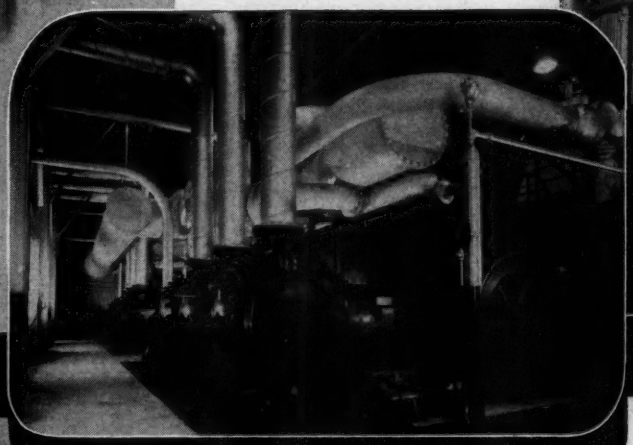
For more than 6 decades CLARK Compressors have been proving their dependability, averaging probably 98% continuous operation with few shut downs and these only after long service. Features are CLARK Super-2-Cycle Fuel Injection, no inlet or outlet valves, large bearings and few, large parts.



CLARK Steam-Driven "Angle" Compressors are offered in 3, 4, 5, 6 and 8-cylinder models ranging from 500 to 4,000 H. P. New, efficient. Ask for Bulletin 200-73.



Three CLARK 1,000 H. P. Supercharged Gas-Driven "Angles", Union Refinery



At left and above: Two views of CLARK 3,000 H. P. Steam "Angles", Union Refinery

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CLARK

No.	Compound	Formula	Molecular Weight	Carbon/Hydrogen Ratio	Melting Point (760 mm.), °F.	Boiling Point (760 mm.), °F.	Critical Constants: Pressure Lbs/Sq.In.	Critical Constants: Temperature °F.	Liquid Density (760 mm., 60°F.): Grms/Ml.	Liquid Density (760 mm., 60°F.): °A.P.I.	Liquid Density (760 mm., 60°F.): Lbs./Gal.	Liquid Density (760 mm., 60°F.): Grm Mols/Ml.	Liquid Density (760 mm., 60°F.): Lb. Mols per 100 Gallons	Gas Density (760 mm., 60°F.) PERFECT GAS: Specific Gravity Air = 1,	Gas Density (760 mm., 60°F.) PERFECT GAS: Lbs. per 1000 Cu. Feet	Gas Density (760 mm., 60°F.) PERFECT GAS: Cu. Ft. Gas per Gal. Liquid	Gas Density (760 mm., 60°F.) PERFECT GAS: Unit Vol. of Gas/Unit Vol. Liq.	Cu. Ft. Gas per Gallon Liquid (Actual)	** Gas Law - Deviation Factor at 760 mm., 60°F.
	Paraffin Series C_nH_{2n+2}																		
1	Methane	CH_4	16.042	2.98	-296.5	-258.5	673	-116.5	(.3)	-	(2.5)	0.019	15.6	0.5538	42.28	59.1	448.1	59.0	1.002
2	Ethane	C_2H_6	30.069	3.97	-297.8	-128.2	708	+90.1	(.4)	-	(3.3)	0.013	11.0	1.0381	79.25	41.6	311.2	41.3	1.008
3	Propane	C_3H_8	44.095	4.45	-305.8	-43.8	617	206.2	0.509	145.5	4.239	0.0113	9.614	1.5222	116.21	36.48	272.9	35.91	1.015
4	n-Butane	C_4H_{10}	58.121	4.76	-218.2	+31.1	551	305.6	0.584	110.8	4.863	0.0100	8.367	2.0065	153.18	31.75	237.5	30.77	1.032
5	Isobutane	C_4H_{10}	58.121	4.76	-229.0	+10.0	544	273.2	0.564	119.4	4.697	0.0097	8.081	2.0065	153.18	30.66	229.4	29.77	1.030
6	n-Pentane	C_5H_{12}	72.147	4.96	-201.5	97.0	485	387.0	0.631	98.8	5.251	0.0087	7.278	2.4908	190.15	27.62	206.6	26.35	1.048
7	Isopentane	C_5H_{12}	72.147	4.96	-257.1	82.4	482	370.0	0.625	94.9	5.201	0.0087	7.209	2.4908	190.15	27.35	204.6	26.17	1.045
8	2,2-Dimethyl Propane	C_5H_{12}	72.147	4.96	+2.1	49.1	485	363	0.598	101.5	4.980	0.0083	6.903	2.4908	190.15	26.20	195.93	25.19	-
9	n-Hexane	C_6H_{14}	86.173	5.11	-139.9	155.7	434	454.6	0.664	81.6	5.526	0.0077	6.413	2.9749	227.11	24.33	182.0	22.82	1.066
10	2,3-Dimethyl Butane	C_6H_{14}	86.173	5.11	-144.8	121.5	-	414.5	0.653	85.2	5.436	0.0076	6.307	2.9749	227.11	23.93	179.0		
11	2,3-Dimethyl Butane	C_6H_{14}	86.173	5.11	-199.5	136.4	451	440.5	0.667	80.6	5.552	0.0077	6.443	2.9749	227.11	24.45	182.9		
12	2-Methyl Pentane	C_6H_{14}	86.173	5.11	-245.2	140.5	-	442.4	0.658	83.6	5.476	0.0076	6.355	2.9749	227.11	24.11	180.4		
13	3-Methyl Pentane	C_6H_{14}	86.173	5.11	-180.4	145.8	469	440.6	0.669	80.0	5.568	0.0077	6.461	2.9749	227.11	24.52	183.4		
14	n-Heptane	C_7H_{16}	100.199	5.21	-131.4	209.1	397	512.6	0.688	74.2	5.727	0.0069	5.716	3.4592	264.06	21.69	162.3	19.95	1.087
15	2-Methyl Hexane	C_7H_{16}	100.199	5.21	-180.8	194.8	400	496.2	0.683	75.7	5.685	0.0068	5.674	3.4592	264.06	21.53	161.1		-
16	n-Octane	C_8H_{18}	114.226	5.30	-70.2	258.1	361	564.8	0.707	68.6	5.885	0.0062	5.152	3.9435	301.05	19.55	146.3	17.77	1.100
17	2,2,4-Trimethyl Pentane	C_8H_{18}	114.226	5.30	-161.3	210.7	360	530.6	0.696	71.8	5.793	0.0061	5.072	3.9435	301.05	19.24	143.9		-
18	n-Nonane	C_9H_{20}	128.252	5.36	-64.7	303.3	337	612.0	0.722	64.5	6.010	0.0056	4.686	4.4276	338.01	17.78	133.0	15.88	1.120
19	n-Decane	$C_{10}H_{22}$	142.278	5.42	-21.5	345.2	312	655.0	0.734	61.5	6.110	0.0052	4.294	4.9119	374.98	16.29	121.9	14.29	1.140
	Olefin Series C_nH_{2n}																		
20	Ethene	C_2H_4	28.052	5.96	-272.6	-154.7	749	49.5	(.4)	-	(3.3)	0.014	11.8	0.9684	73.93	44.6	333.7	44.33	1.006
21	Propene	C_3H_6	42.079	5.96	-300.8	-54.0	668	196.8	(.5)	-	(4.2)	0.012	10.0	1.4527	110.90	37.9	283.5	37.41	1.013
22	Butene-1	C_4H_8	56.105	5.96	-319.0	+20.4	-	291.2	0.600	104.3	5.001	0.0107	8.914	1.9370	147.87	33.81	252.9	33.15	1.020
23	cis Butene-2	C_4H_8	56.105	5.96	-218.7	+38.7	-	311.0	0.615	98.6	5.118	0.0110	9.122	1.9370	147.87	34.61	258.9	33.93	1.020
24	trans Butene-2	C_4H_8	56.105	5.96	-158.4	33.7	-	311.0	0.615	98.6	5.118	0.0110	9.122	1.9370	147.87	34.61	258.9	33.93	1.020
25	Isobutene	C_4H_8	56.105	5.96	-221.3	19.4	-	290.3	0.603	103.2	5.018	0.0107	8.944	1.9370	147.87	33.94	254.0	33.27	1.020
26	Pentene-1	C_5H_{10}	70.131	5.96	-209.6	86.2	595	394.2	0.648	86.9	5.393	0.0094	7.693	2.4211	184.83	29.18	218.3	28.33	1.030
27	Pentene-2	C_5H_{10}	70.131	5.96	-218.4	98.8	-	376.9	0.655	84.5	5.452	0.0093	7.774	2.4211	184.83	29.50	220.7	28.64	1.030
28	2-Methylbutene-2	C_5H_{10}	70.131	5.96	-191.2	101.5	-	377	0.664	81.6	5.526	0.0093	7.880	2.4211	184.83	29.90	223.7		
29	3-Methylbutene-1	C_5H_{10}	70.131	5.96	-211.0	68.2	498	377	0.635	91.3	5.285	0.0091	7.536	2.4211	184.83	28.59	213.9		
30	Hexene-1	C_6H_{12}	84.157	5.96	-216.4	146.3	-	470.3	0.679	76.9	5.652	0.0081	6.716	2.9054	221.80	25.48	190.6		
31	Heptene-1	C_7H_{14}	98.183	5.96	-183.5	199.6	-		0.702	70.1	5.843	0.0071	5.951	3.3895	258.76	22.56	168.9		
32	Octene-1	C_8H_{16}	112.210	5.96	-156.2	252.5	-	580.6	0.720	65.0	5.994	0.0064	5.342	3.8738	295.73	20.27	151.6		
33	Nonene-1	C_9H_{18}	126.232	5.96	-	301.8	-	-	0.735	61.0	6.119	0.0058	4.847	4.3579	332.69	18.39	137.6		
34	Decene-1	$C_{10}H_{20}$	140.262	5.96	-112	341.6	-	-	0.748	57.7	6.227	0.0053	4.440	4.8424	369.67	16.84	126.0		
	Aromatic Series C_nH_{2n-6}																		
35	Benzene	C_6H_6	78.108	11.91	+41.9	176.2	700	551.3	0.882	28.9	7.344	0.0113	9.402	2.6966	205.86	35.67	266.9	34.63	1.030
36	Toluene	C_7H_8	92.134	10.43	-139.2	230.9	611	609.1	0.870	31.1	7.244	0.0094	7.862	3.1807	242.82	29.83	223.2	28.68	1.040
37	m-Xylene	C_8H_{10}	106.140	9.53	-53.3	282.2	525	654.1	0.867	31.7	7.219	0.0082	6.800	3.6643	279.74	25.81	193.1	24.58	1.050
38	O-Xylene	C_8H_{10}	106.140	9.53	-13.3	291.2	542	676.9	0.883	28.8	7.353	0.0083	6.928	3.6643	279.74	26.29	196.7	25.03	1.050
39	p-Xylene	C_8H_{10}	106.140	9.53	+55.8	281.1	515	651.4	0.864	32.3	7.194	0.0081	6.778	3.6643	279.74	25.72	192.4	24.50	1.050
	Additional Compounds																		
40	Acetylene	C_2H_2	26.036	11.91	-113.8	-118.5*	911	96.8	-	-	-	-	-	0.8989	68.62	-	-	-	-
41	Cyclohexane	C_6H_{12}	84.157	5.96	+43.5	+177.4	594	537.8	0.783	49.2	6.520	0.0093	7.747	2.9054	221.80	29.40	219.9	28.27	1.006
42	Methylcyclopentane	C_6H_{12}	84.157	5.96	-224.9	+161.4	-	-	0.754	56.2	6.277	0.0090	7.465	2.9054	221.80	28.00	209.5		1.040
43	Acetone	C_3H_6O	58.078	-	-138.5	133.7	691	455	0.798	44.5	6.695	0.0197	11.529	2.005	153.07	43.74	327.2		
44	Diethyl ether	$C_2H_5OC_2H_5$	74.120	-	-177.3	94.3	523	381	0.719	65.2	7.194	0.0098	9.706	2.5569	195.35	34.83	275.5		
45	Phenol	C_6H_5OH	94.108	-	+106.5	358.6			1.061	-0.6	8.227	0.0115	6.617	3.2498	248.02	25.11	187.8		
	Diesel Standards																		
46	Cetane	$C_{16}H_{34}$	226.432	5.62	+64.6	536.0	222	862	0.779	50.1	6.486	0.0034	2.864	7.817	596.77	10.87	81.3		
47	Cetene	$C_{16}H_{32}$	224.416	5.96	+39.2	525.2			0.788	48.1	6.560	0.0035	2.923	7.7476	591.46	11.09	83.0		
48	Alpha-Methylnaphthalene	$C_{11}H_{10}$	142.190	13.11	-7.8	469.4			1.022	6.2	8.562	0.0072	6.022	4.9089	374.75	22.85	170.9		
	Alcohols																		
49	Methyl Alcohol	CH_3OH	32.042	-	-144.0	148.1	1157	464.0	0.796	46.3	6.627	0.0248	20.682	1.1062	84.45	78.47	587.0	76.93	1.02
50	Ethyl Alcohol	C_2H_5OH	46.069	-	-179.1	173.3	927	469.6	0.793	46.82	6.607	0.0172	14.342	1.5905	121.42	54.42	407.1	53.35	1.02
	Miscellaneous																		
51	Carbon	C	12.010	-	+6300	-	-	-	-			-	-	-	-				
52	Hydrogen	H_2	2.016	-	-434.4	-422.9	188	-399.8	0.071					0.0696	5.313				0.9993
53	Oxygen	O_2	32.000	-	-361.1	-297.4	730	-181.8	1.140					1.1048	84.34				1.00075
54	Nitrogen	N_2	28.016	-	-345.6	-320.4	492	-232.8	0.808					0.9672	73.84				1.0003
55	Carbon Monoxide	CO	28.010	-	-340.6	-313.6	514	-218.2	0.801					0.9670	73.82				1.0013
56	Carbon Dioxide	CO_2	44.010	-	-	-109.3	1073	+88.0	(1.56 solid)					1.5194	115.99				1.0056
57	Hydrogen Sulphide	H_2S	34.076	-	-121.9	-76.5	1306	+212.7	0.790	47.6	6.580			1.1763	89.79	73.28	548.2	72.48	1.0110
58	Sulphur Dioxide	SO_2	64.06	-	-98.9	+14.0	1230	+424.9	1.460	-	-			2.2122	168.88				1.0106
59	Water	H_2O	18.016	-	+32.0	+212	3206	+705.4	0.999	10.0	8.328			0.6220	47.482	175.39	1312.1	173.74	1.0095
60	Air	-	28.956	-	-	-317.7	547	-221.3	0.855					1.0000	76.341				1.00039

*Sublimes

*Densities at B. P. except for water

**$Y = \frac{BT}{PV}$

LIGHT HYDROCARBONS AND MISCELLANEOUS COMPOUNDS

Specific Heat at 760 mm. & 60°F.				Heat of Combustion (Dry Basis)						Heat of Vaporization at 760 mm. & B.P., Btu/Lb.	Heat of Fusion at 760 mm., Btu/Lb.	Air Required for Combustion		Inflammability Limits Vol. % in Air Mixture		Refractive Index n_D^{20}	Aniline Point °F.	Octane Number		Compound	No.
				Gaseous State PERFECT GAS				Liquid State B.t.u./Gallon													
Gas			Liquid	B.t.u./Lb. Vapor		B.t.u. per Cu.Ft. Vapor															
C_p	C_v	C_p/C_v	C_p	Gross	Net	Gross	Net	Gross	Net			Lbs. per Lb.	Cu.ft./Cu.ft. (Perfect Gas)	Lower	Higher			Motor Method	Research Method		
																				Paraffin Series C_nH_{2n+2}	
0.330	0.405	1.309		23,920	21,540	1,011	910	-	-	245	25.2	17.20	9.53	5.0	15.0		-	100+		Methane	1
0.415	0.346	1.198		22,350	20,450	1,770	1620	73,390	67,110	211	40.9	16.06	16.67	3.22	12.45		-	100+		Ethane	2
0.376	0.324	1.161		21,690	19,960	2,520	2319	91,330	84,000	180	34.4	15.65	23.32	2.37	9.50		-	99.5		Propane	3
0.357	0.312	1.144	0.55 @ 32°F	21,340	19,700	3,266	3014	102,990	95,010	166	32.4	15.43	30.97	1.86	8.41		181.2	90.5		n-Butane	4
0.357	0.312	1.144	0.55 @ 32°F	21,290	19,650	3,261	3010	94,620	91,610	158	-	15.43	30.97	1.80	8.44		225.7	97.0		Isobutane	5
0.347	0.309	1.121	0.64	21,120	19,340	4,016	3714	109,980	101,660	153	49.9	15.30	38.11	1.40	7.80	1.3577	159.3	61		n-Pentane	6
			0.53	21,060	19,470	4,004	3702	108,690	100,970	146	30.4	15.30	38.11	1.32	-	1.3540	168.3	89		Isopentane	7
			-	20,990	19,400	3,990	3689	-	-	136	-	15.30	38.11	-	-	1.3390				2,2-Dimethyl Propane	8
0.339	0.305	1.113	0.536	20,970	19,420	4,762	4410	114,910	106,350	146	65.0	15.21	45.26	1.25	6.90	1.3750	135.5	25		n-Hexane	9
			-	20,855	19,300	4,736	4384	112,620	104,200	138		15.21	45.26	-	-	1.3689	*178.1	94		2,2-Dimethyl Butane	10
			-	20,890	19,340	4,744	4392	115,220	106,620	137		15.21	45.26	-	-	1.3751	*161.4	95		2,3-Dimethyl Butane	11
			-	20,910	19,360	4,748	4396	113,720	105,240	140		15.21	45.26	-	-	1.3715	*165.0	73		2-Methyl Pentane	12
			-	20,920	19,370	4,751	4399	115,690	107,070	141		15.21	45.26	-	-	1.3766	*156.8	75		3-Methyl Pentane	13
0.335	0.302	1.109	0.529	20,860	19,340	5,508	5106	118,470	109,760	138	59.6	15.15	52.41	1.00	6.0	1.3878	159.1	0	0	n-Heptane	14
			0.519	20,820	19,300	5,498	5097	117,400	108,750	-	38.2	15.15	52.41			1.3850	165.2	45		2-Methyl Hexane	15
0.330	0.300	1.100	0.517	20,780	19,270	6,254	5802	121,270	112,440	131	77.7	15.10	59.55	.95	-	1.3976	161.1	-17		n-Octane	16
			0.492	20,560	19,060	6,190	5738	119,180	110,410	117	34.0	15.10	59.55			1.3915	*176.8	100	100	2,2,4-Trimethyl Pentane	17
0.327	0.299	1.093	0.518	20,710	19,220	7,000	6496	123,470	114,530	125	74.0	15.06	66.70	.83	-	1.4056	166.1	-28		n-Nonane	18
0.323	0.298	1.084	0.517	20,660	19,180	7,745	7192	125,260	116,330	120	87.0	15.04	73.85	.67	-	1.4120	171.5	-53		n-Decane	19
																				Olefin Series C_nH_{2n}	
0.362	0.288	1.258		21,650	20,300	1,601	1500	70,910	66,430	208	51.4	14.76	14.29	2.75	28.60				100	Ethene	20
0.351	0.298	1.180		21,060	19,700	2,335	2184	87,740	82,030	189	31.0	14.76	21.44	2.00	11.10				100	Propene	21
0.346	0.303	1.145	0.54	20,860	19,500	3,084	2883	103,430	96,680	174	-	14.76	28.58	1.70	9.00			80		Butene-1	22
			0.52	20,800	19,440	3,074	2874	-	-	187	56.1	14.76	28.58					83		cis Butene-2	23
			0.55	20,770	19,410	3,071	2870	-	-	183	75.6	14.76	28.58					83		trans Butene-2	24
			0.555	20,740	19,380	3,066	2865	-	-	167	45.4	14.76	28.58					67		Isobutene	25
			-	20,720	19,360	3,829	3578	110,850	103,520	148	46.3	14.76	35.73	1.60	-	1.3714	66.2		92	Pentene-1	26
			0.515									14.76	35.73			1.3797	64.4		98	Pentene-2	27
			0.508									14.76	35.73			1.3676				2-Methylbutene-2	28
			-									14.76	35.73			1.3677				3-Methylbutene-1	29
			0.506	20,630	19,270	4,575	4274	115,660	107,980	149		14.76	42.88			1.3886	73.0		80	Hexene-1	30
			0.488	20,560	19,200	5,320	4969	119,160	111,240	149	55.5	14.76	50.02			1.3999	81.0		54	Heptene-1	31
			0.486	20,510	19,150	6,066	5664	121,960	113,810	129		14.76	57.17			1.4103	*89.2		39	Octene-1	32
			0.485	20,480	19,120	6,811	6359	-	-			14.76	64.32			1.4161	100.4		-	Nonene-1	33
			-	20,440	19,080	7,556	7054	-	-			14.76	71.45			1.4259	*114.7		-	Decene-1	34
																				Aromatic Series C_nH_{2n-6}	
0.256			0.414	18,225	17,490	3,750	3600	132,810	127,410	170	54.9	13.25	35.70	1.41	6.75	1.5012				Benzene	35
			0.397	18,470	17,640	4,480	4280	132,800	126,790	156	31.0	13.35	42.88	1.27	6.75	1.4969				Toluene	36
			0.404	18,680	17,780	5,226	4970	134,240	127,720	147	45.5	13.65	50.02			1.4974				m-Xylene	37
			0.412	18,760	17,880	5,250	5000	136,360	129,740	149	52.8	13.65	50.02	1.0	6.0	1.5055				o-Xylene	38
			0.402	18,620	17,720	5,210	4956	133,110	126,620	146	68.5	13.65	50.02			1.4962				p-Xylene	39
																				Additional Compounds	
0.407	0.321	1.269	-	21,560	20,850	1,469	1439	-	-	296	-	13.25	11.91	2.5	80.0	-	-	-		Acetylene	40
-	-	-	0.429	20,290	18,930	4,500	4200	131,180	122,320	154	13.3	14.76	42.88	1.33	8.35	1.4263	85.8	77		Cyclohexane	41
-	-	-	0.447					125,850	117,320	154	35.1	14.76	19.06			1.4098	93.2			Methylcyclopentane	42
-	-	-	-					88,560	81,970	224	42.2	9.51	28.59			1.3591				Acetone	43
-	-	-	-					93,770	86,070	151	-	11.17	33.35			1.3497				Diethyl Ether	44
-	-	-	-					126,450	119,140	-	52.2	10.27	33.35							Phenol	45
																				Diesel Standards	
				*20,360	*18,920	-	-	-	-	76	112	14.93	116.72			1.4344				Cetane	46
				20,316	18,957			131,990	123,070			14.76	114.34			1.4417				Cetene	47
				-	-	-	-	-	-			13.10	64.32							Alpha-Methylnaphthalene	48
																				Alcohols	
0.380	.324	1.203	0.572	10,250	9,060	865	765	64,600	56,710	473	42.7	6.46	7.15	6.72	36.50	1.3288				Methyl Alcohol	49
0.406	.359	1.130	0.553	13,150	11,910	1,596	1,445	84,290	76,080	368	45.4	8.99	14.30	3.28	18.95	1.3610				Ethyl Alcohol	50
																				Miscellaneous	
-	-	-		*14,100																Carbon	51
3.4	2.420	1.41		61,042	51,530	324	273	-	-	194	27.3	34.23	2.38	4.0	74.2					Hydrogen	52
0.218	0.155	1.401		-	-	-	-	-	-	92	5.9	-	-	-	-					Oxygen	53
0.248	0.176	1.404		-	-	-	-	-	-	86	11.0	-	-	-	-					Nitrogen	54
0.248	0.176	1.404		4,350	-	321	-	-	-	91	14.4	24.63	2.38	12.50	74.2					Carbon Monoxide	55
0.199	0.153	1.304		-	-	-	-	-	-	-	81.5	-	-	-	-					Carbon Dioxide	56
0.254	0.192	1.320		7,490	6,920	672	621	-	-	236	30.0	6.07	7.15	4.30	45.5					Hydrogen Sulphide	57
0.152	0.116	1.390		-	-	-	-	-	-	171	-	-	-	-	-					Sulphur Dioxide	58
0.486	0.345	1.335	1.000	-	-	-	-	-	-	970	143.0	-	-	-	-	1.3330				Water	59
0.241	0.171	1.410								92	-	-	-	-	-					Air	60

*Solid State

*Critical Solution Temperature

BIBLIOGRAPHY REFERENCE NUMBERS

No.	Compound	Melting Point	Boiling Point	Critical Pressure	Critical Temp.	Grams/Mol.	Gas Law Deviation Factor	Specific Heats Cp	Cv	Cp/Cv	Cp Liq.	Heat of Fusion	Heat of Vaporization	Heats of Combustion Gaseous	Heats of Combustion Liquid	Inflammability Limits
	Paraffin Series C_nH_{2n+2}															
1.	Methane	1	2	21	21	17,19	35,36	4	4	4	-	1	80	48	92	53
2.	Ethane	60	60	58	22	21	37	4	4	4	-	60	80	4,48	92	53
3.	Propane	59	59	23	23	7,27,61	7,27,38	4	4	4	-	59	80	4,48	92	53
4.	n-Butane	1	8,9,10	58	58	28	39	4	4	4	46	1	80	4,2	78	53
5.	Isobutane	2	8	21	21	2	29	4	4	4	46	-	80	4,74	92	53
6.	n-Pentane	3	11,12,13	21	21	12,13,30	40	4	4	4	40	1	81	4,48	78	53
7.	Isopentane	3	14	21	21	14,31	29	-	-	-	45	1	80	75,97	92	53
8.	2,2-Dimethyl Propane	-67	2	77	77	71	-	-	-	-	-	-	80	75,76		-
9.	n-Hexane	3	11,13,15,16	21	21	15,16,31	29	4	4	4	47	1	80	4,48	78	53
10.	2,2-Dimethyl Butane	87	87	-	110	71		-	-				80	92,91	120	
11.	2,3-Dimethyl Butane	87	87	77	111	32		-	-	-	-		80	92,91	120	
12.	2-Methyl Pentane	32	3	-	77	32	-	-	-	-	-		80	92,91	120	
13.	3-Methyl Pentane	32	3	70	77	32	-	-	-	-	-		80	92,91	120	
14.	n-Heptane	3	15,18	24	24	13,30	29	4	4	4	45	1	80	4,48	46,78	53
15.	2-Methyl Hexane	3	3	77	77	7	-	-	-	-	45	1		92,91	95	
16.	n-Octane	3	11	21	21	71	34	34	34	34	47	1	80	75,48	47,78	53
17.	2,2,4-Trimethyl Pentane	3	3	21	21	33	-	-	-	-	45	1	80	92,91	79	
18.	n-Nonane	3	3	25	25	2	34	34	34	34	47	1	80	75,48	47,78	53
19.	n-Decene	1	11	25	25	6	34	34	34	34	47	1	80	75,48	47,78	53
	Olefin Series C_nH_{2n}															
20.	Ethene	66	66	21	21	34	6	4	4	4	-	66	66	4,77,49	91,92	53
21.	Propene	1	5	88	88	34	6	4	4	4	-	89	89	4,77,49	91,92	53
22.	Butene-1	64	5	-	25	8	34	4	4	4	64	-	45	4,77,49	91,92	53
23.	cis Butene-2	5	5	-	25	8	34				64	64	5	96		-
24.	trans Butene-2	5	5	-	25	8	34				64	64	5	96		-
25.	Isobutene	5	5	-	25	8	34				64	64	45	96		-
26.	Pentene-1	1	71	77	25	71	6				-	1	46	49,77,75	91,92	53
27.	Pentene-2	72	72	-	25	71	6				45	-				
28.	2-Methylbutene-2	2	71	-	-	71	-				45	-				
29.	3-Methylbutene-1	6	71	77	77	71	-					-				
30.	Hexene-1	68	68	-	25	71	-				46	-	83	49,77,75	91,92	
31.	Heptene-1	65	71	-	-	71	-				45	65	114	49,77,75	91,92	
32.	Octene-1	69	71	-	25	71	-				45	-	84	49,77,75	91,92	
33.	Nonene-1	-	2	-	77	71	-				45	-	-	49,77,75		
34.	Decene-1	82	2	-	-	71	-				-	-	-	49,77,75		
	Aromatic Series C_nH_{2n-6}															
35.	Benzene	1	77	21	21	117	6				44	1	80	91,92	90	53
36.	Toluene	1	77	21	21	117	6				45	1	46	91,92	90	53
37.	m-Xylene	115	77	77	25	117	6				45	1	46	91,92	90	-
38.	o-Xylene	1	77	77	25	117	6				45	1	46	91,92	90	53
39.	p-Xylene	1	117	77	25	117	6				45	1	46	91,92	90	-
	Additional Compounds															
40.	Acetylene	116	2	21	21	-		4	4	4			45	46		53
41.	Cyclohexane	3	3	21	21	77					44	1	46	92,94	90,91	53
42.	Methylcyclopentane	3	3	-	-	77					47	3	77		77	-
43.	Acetone	85	85	112	112	85,86						85	85		95	-
44.	Diethyl Ether	86	86	85	85	85,86							85		95	-
45.	Phenol	85	85	-	-	85						85			95	-
	Diesel Standards															
46.	Cetane	70	71	109	109	121						118		46		
47.	Cetene	71	2	-	-	71								49	91,92	-
48.	Alpha-Methylnaphthalene	2	2	-	-	2									-	-
	Alcohols															
49.	Methyl Alcohol	2	2	21	21	6	6				44	46	46	93,16,75	93,16,75	53
50.	Ethyl Alcohol	2	2	21	21	6	6				44	46	46	93,16,75	93,16,75	53
	Miscellaneous															
51.	Carbon	2	-									-		45		-
52.	Hydrogen	2	2	21	21	2	6	45	45			46	6	44		53
53.	Oxygen	2	2	21	21	2	29	45	45			46	6			-
54.	Nitrogen	2	2	21	21	2	29	45	45			6	6			-
55.	Carbon Monoxide	6	2	21	21	2	6	45	45			46	6	50		53
56.	Carbon Dioxide	-	2	21	21	2	29	45	45			46	-			-
57.	Hydrogen Sulphide	20	20	21	21	.62	29	45	45			20	20	57		53
58.	Sulphur Dioxide	2	2	21	21	2	6	45	45			-	46			-
59.	Water	2	2	26	26	2	6	45	45			46	46			-
60.	Air		2	21	21	2	35	34	45	63		-	6			-

Inflammability Limits	Refractive Index N_D^{20}	Aniline Point	Octane Number Motor Method	Octane Number Research Method
53	-		54	
53	-		54	
53	-		53	
53	-	98	53	
53	-	98	53	
53	101	98	103	
53	101	100	103	
-	102	-		
53	101	98	103	
	101	99	105	
	101	99	102	
	101	98	103	
	101	99	103	
53	101	98		
	101	100	102	
53	101	98	103	
	101	99	103	
53	101	98	106	
53	102	98	107	
				77
53				77
53			77	
-			77	
-			77	
-			77	
53	106	100		77
	77	77		77
	106			-
	106			-
	106	100		77
	106	100		77
	106	77		77
	106	100		-
	77	77		-
53				
53	117			
-	117			
53	117			
-	117			
53		100		
53	106	100	77	
-	106	101		
-				
-	85			
-	85			
-				
121				
-	106			
-				
53	85			
53	85			
-				
53				
-				
53				
-				
55				
-				
-				
-	85			

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ploying the usual stoichiometric formulas and taking 21% as the oxygen content of the air.

11. Inflammability Limits

All values shown in these columns were taken from Jones' paper (Ref. No. 53 in Table II).

12. Refractive Index

Data were taken from sources noted in the bibliography.

13. Aniline Point

The values given here are ASTM aniline points (8) except those preceded by asterisks which are critical solution temperatures of the hydrocarbon in aniline. In general, the difference between the ASTM aniline point and the critical solution temperature is of the order of one degree Fahrenheit or less for the hydrocarbons up to C_{10}.

14. Octane Number

The octane numbers chosen for inclusion represent the best available published information.

In working with pure compounds the use of Table I is straightforward, though possibly a word of explanation of the part played by the gas law deviation factor is in order.

This quantity enters as a multiplying factor in gas metering and in calculating the actual heating value of a gas. For example, the volume of gas Q_a, delivered by a displacement meter, is equal to the theoretical displacement, Q_t, multiplied by Y, the deviation factor, or, in the case of an orifice meter, the flow rate as given by the design of the meter on a perfect gas basis is multiplied by the square root of the factor,

$$\sqrt{Y}$$

For a complete discussion of this phase of gas metering reference should be made to the C.N.G.A. publication (9) on metering.

The calorific value of a real gas is the product of the heat of combustion in Btu per cubic foot, as given in Table I, multiplied by the gas law deviation factor.

For high accuracy in fractional analysis by distillation, all gas volumes should be corrected for deviation from the perfect gas laws by applying the proper deviation factors. The method of adjusting gas volumes on this basis is discussed fully in a recent C.N.G.A. bulletin (10).

Mixtures of compounds introduce thermodynamic complications, many of which can be overcome only by resort to direct experiment. For example, mixtures of certain of the hydrocarbons listed in the table with the alcohols will form azeotropes, that is, constant boiling mixtures.

Critical temperatures and pressures of mixtures are best obtained by experiment.

Where high accuracy is desired in problems involving density of mixtures of liquids the density should be measured. The reason for this becomes obvious when it is realized that a 50-50 volume per cent mixture of butane and decane, for example, will exhibit a contraction of approximately 0.6% over the calculated specific volume. On the other hand, a mixture of benzene and n-hexane will undergo an expansion of 0.5% over that calculated from the densities of the respective components in a 50-50 volume per cent mixture.

In essentially its present form Table I has found wide application in research and engineering activities of the company with which the authors are connected. Much constructive criticism was received from the members of the various technical staffs of the company and the Physical Constants Committee of the California Natural Gasoline Association to whom grateful appreciation is extended.

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SUMMARY OF BASIC CONSTANTS

Gallons per Cubic Foot	=	7.481
Liters per Cubic Foot	=	28.316
Molecular Weight of Air	=	28.966
Density of Water at 60° F.	=	0.99904
Volume of Ideal Gas, Liters per Mol. at 0° C., 1 atm.	=	22.4140
Ice Point, Degrees Rankine	=	492
Grams per pound (Adv.)	=	453.592

California Standard Issues Statement

The Standard Oil Co. of California issues the following statement:

"Standard Oil Co. of California is in no way whatsoever involved in the assertions of the Department of Justice concerning relationship between Standard Oil Co. of New Jersey and the Axis countries.

"The company is not in any way interested in the patents for manufacturing of synthetic rubber under discussion."

John B. Schuyler Moved to Denver

The Office of Petroleum Coordinator has announced that John B. Schuyler, materials specialist, has opened a materials division in the District 4 office at Denver, to aid Rocky Mountain oil operators in obtaining priority ratings.

Mr. Schuyler will have headquarters in the office of Michael J. Foley, director in charge of District 4, U. S. National Bank Building, Denver.

He began his career as a materials specialist in 1912, when he joined the Oil Well Supply Co. as a field salesman stationed in Casper, Wyo. Three years later he went with the National Supply Co., with which he served in various posts until he became district manager of sales and engineering in 1920.

Later, Mr. Schuyler moved to California and served with a number of organizations. He was sales manager and vice president of the Baash-Ross Tool Co., and, later, manager of the tubular department of the American Pipe and Steel Corp.

He joined the staff of the Office of Petroleum Coordinator in January 1942.

Fuel Economy In Refineries

A Timely A. P. I. Presentation

D. C. Lawrence
The Texas Co.

ABSTRACT

Because fuel costs represent 20 to 30 per cent of total direct operating costs in an oil refinery, it is a very attractive field to attack in an effort to reduce operating expenses.

Fuel is used to generate utilities and for process work. Fuel consumption is divided about equally between utility generation and process work.

Fuel costs for utilities can be kept to a minimum by efficient generation and usage.

Inasmuch as generating facilities and the necessary operating personnel are centralized and operation is routine, the efficient generation of utilities should not present any particular problem.

Usage of utilities, a quite different problem. Products from the various processes change with consumer demand, seasons, etc., which vary the utility requirement, changing loadings on utility systems, individual drives, etc. To maintain a high efficiency in usage, constant modifications and changes are required.

Fuel consumed by the processes may be reduced by efficient heater design, by heat exchange from hot streams to incoming charge, to reboilers, to steam generators, to boiler feed water, etc.

In other words, all available heat should be used, if economically possible, for some useful purpose rather than absorbed by the plant water supply.

One of the largest single items of direct operating expenses for refinery operations is fuel. Depending upon the type of operations carried on in a particular oil refinery, fuel costs probably will be in the range of 20 to 30 per cent of total direct operating expenses, excluding overhead costs. Because fuel costs represent such a large percentage of total operating cost, it is a very attractive field to attack in an effort to reduce operating expenses.

Fuel usage in a refinery may be considered under two classifications:

1. Fuel consumed to provide necessary utilities, such as steam, electric power, fire protection, etc.
2. Fuel used directly in processing refinery products.

When all power is generated in the refinery, the fuel cost for utilities will be in the range of 40 to 50 per cent of the total refinery fuel cost. Fuel used directly for process work is, of course, in about the same order of magnitude.

The quantity of fuel required to provide utilities for a refinery may be reduced by:

1. More efficient generation of utilities.
2. More efficient usage of utilities by the various consumers.

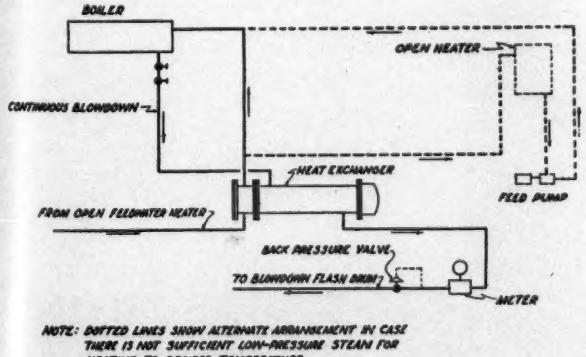
GENERATION OF UTILITIES

Due to the centralization of generating equipment and personnel, the economic production of utilities does not present as complicated a problem as does the economical usage of utilities by a great number of varied and widely scattered processes.

Fuel consumed for the generation of utilities is burned primarily under boilers or steam generators. For this reason, any reduction in utilities will represent a reduction in fuel consumed. The steam may be generated at the pressure required for process drives or process use, in which case it goes direct from the boiler to the steam-distribution system. If electric-power generating equipment is installed, the steam would be generated at an economical pressure and temperature to provide power requirements, and turbo generators would be used to reduce the pressure and temperature at which steam was generated consistent with process requirements.

New steam and power-generating plants would be designed for maximum economical efficiency, consistent with steam and power balance and price of fuel.

Air heaters and economizers would be utilized to lower stack-gas temperatures. Open feed-water heaters using low-pressure steam, or closed high-pressure heaters exchanging heat from blowdown, or other sources of refinery waste heat would be used to raise the temperature of the feed water going to the boiler.


BOILER
OPEN HEATER
CONTINUOUS BLOWDOWN
HEAT EXCHANGER
FEED PUMP
FROM OPEN FEEDWATER HEATER
BACK PRESSURE VALVE
TO BLOWDOWN FLASH DRUM
METER
NOTE: DOTTED LINES SHOW ALTERNATE ARRANGEMENT IN CASE THERE IS NOT SUFFICIENT LOW-PRESSURE STEAM FOR HEATING TO DESIRED TEMPERATURE

Heat Exchange from Blowdown to Feed Water
Figure 1

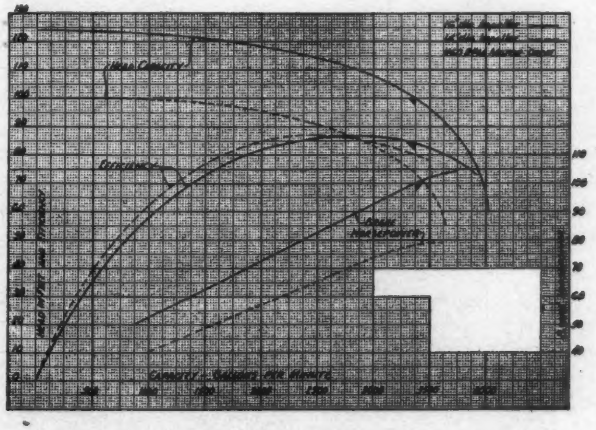
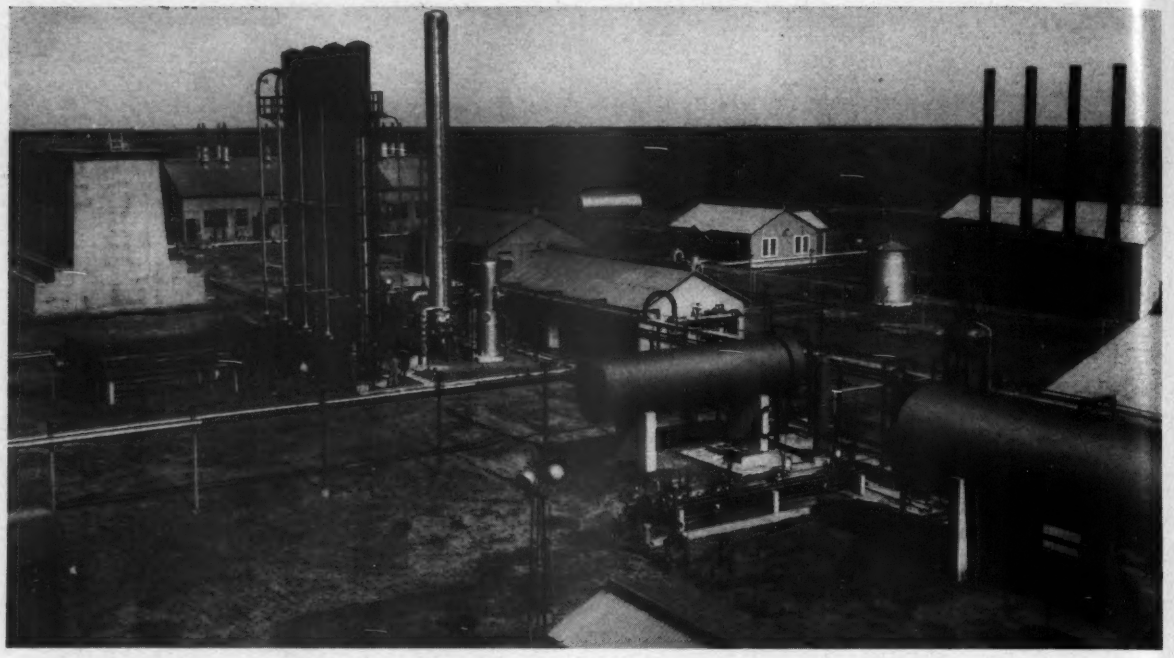


Figure 2



Hats off! to

THE CHICAGO CORPORATION

on completion of the large addition to the WARDNER plant.

We are proud of our part in this work, which covers

1st. The Original Plant. This was the first large Distillate Recovery and Pressure Maintenance Plant in the Industry.

2d. Changes and Additions. These doubled the capacity of the Plant to 120 mm/cf per day, and converted it to the Absorption Process.

All of the work was done by us on a Turn-key basis, including design, furnishing all materials, fabrication of equipment in our own Shops and field installation with our own construction forces.

Our ability to handle all phases of projects speeds completion and assures efficient, economical installations.

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LOS ANGELES CALIFORNIA

- *Distillate Recovery Plants*
- *Gas Dehydration Plants*
- *Compressor Stations*
- *Natural Gasoline Plants*
- *Stabilization Plants*

AFFILIATED WITH

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Older generating plants, in many instances, can be replaced or supplemented with equipment of modern design at very attractive rates of return on the investment cost. This is due to increased efficiency of the steam-generating equipment and the generation of low-cost by-product electric power.

A recent installation of this nature was made in one of our refineries, which is located at Port Arthur, Texas, and which has been discussed in articles appearing in several technical magazines.

Before the new power plant was built, utilities for the refinery had been supplied by a power plant generating steam at 215 psi from boilers having a capacity of 7,440 hp. Steam from these boilers was supplied to three 3,000-kw 2,400-volt turbo-generators—two of which exhausted to 27 in. mercury vacuum, and one exhausted against 15 psi back pressure. Any surplus steam not required by the turbo-generators went to the plant steam-distribution system through a pressure-reducing and desuperheating station. The remainder of the refinery steam requirements was supplied from 150-psi boilers aggregating 20,000 hp. Power generation was supplemented with purchased power.

Because refinery operations were to be increased, a study of existing steam and power-generating facilities was made, and it was found that a high-pressure power plant generating steam at 600 lb. and exhausting at 150 lb. offered the greatest economy. Installation of the new power plant made possible attractive economies, due to increased efficiency of the new boilers, the generation of all power requirements, and the elimination of purchased power. Many of the older less efficient boilers were retired from service.

Attractive economies often can be made by a study of old boiler plants. The installation of blowdown exchangers, more efficient burners, more efficient maintenance of furnaces and baffles, fans, pumps, etc., and more efficient combustion controls are some of the many items which may be investigated to improve the efficiency of old existing plants.

HEAT EXCHANGE FROM BOILER BLOWDOWN

Waste heat from boiler blowdown or other sources may be utilized to increase feed-water temperature by the installation of heat-exchange equipment.

The flow diagram illustrated in Fig. 1 shows one arrangement of such equipment. In this instance a surplus of low-pressure steam for feed-water heating was available. After the feed water had been heated to the maximum temperature obtainable with the low-pressure steam, it was passed through the blowdown heat exchanger and additional heat was recovered—as the blowdown was at a higher heat level than the low-pressure steam available for heating. If there is a shortage of low-pressure steam, the blowdown heat exchanger could be installed in the system ahead of the low-pressure steam, as shown by dotted lines.

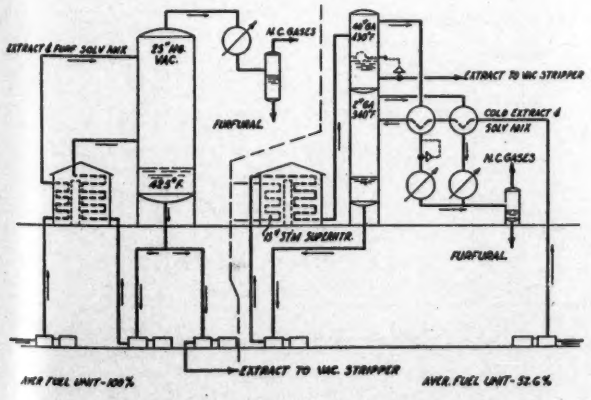
Boiler efficiency will be increased roughly 1 per cent for each 10-deg-F rise in feed-water temperature on boilers operating at 150 psi pressure and no superheat.

Steam Atomizing-Oil Burners

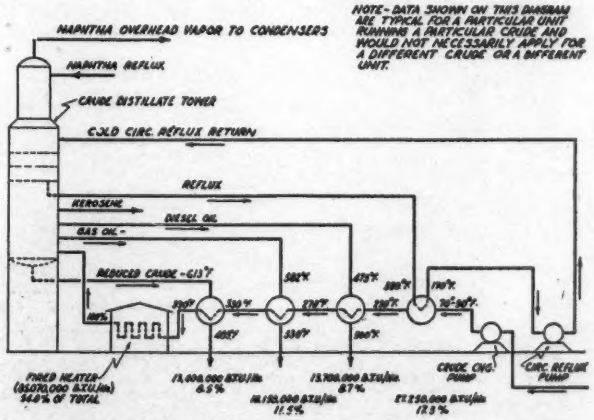
Obsolete or "home-made" steam atomizing-oil burners often use excessive amounts of steam for atomization. Steam-consumption tests, which were made on various makes of steam atomizing-oil burners, indicate that steam required for correct atomization will vary from 1½ to 6 per cent of total generation or from 0.20 lb. to 0.85 lb. steam per pound of oil atomized. The burners taking 1½ per cent of the total generation represent the better commercial burners, and "home-made" burners account for the figure of 6 per cent. The usual consumption for commercial burners, when properly adjusted and maintained, is in the range of 2.5 to 3.0 per cent. Consumption may exceed this appreciably, however, if the burners are not maintained properly and if the operators do not adjust the burners for the minimum steam requirement to give proper atomization.

Usage of Utilities

After utilities have been generated as economically as possible



Two-Stage Distillation Solvent Recovery Unit
Figure 3


NAPHTHA OVERHEAD VAPOR TO CONDENSERS
NOTE - DATA SHOWN ON THIS DIAGRAM ARE TYPICAL FOR A PARTICULAR UNIT RUNNING A PARTICULAR CRUDE AND WOULD NOT NECESSARILY APPLY FOR A DIFFERENT CRUDE OR A DIFFERENT UNIT.
NAPHTHA REFLUX
CRUDE DISTILLATE TOWER
COLD CIRC. REFLUX RETURN
REFLUX
KEROSENE
DIESEL OIL
GAS OIL
REDUCED CRUDE - 613°F
FIRED HEATER (85,070,000 BTU/hr.) 44.8% OF TOTAL
13,400,000 BTU/hr. 6.5%
14,150,000 BTU/hr. 11.5%
13,700,000 BTU/hr. 6.7%
27,250,000 BTU/hr. 12.3%
CRUDE CHG. PUMP
CIRC. REFLUX PUMP

Heat Exchange from Hot Streams to Crude Charge
Figure 4

and put into the distribution systems, we then are confronted with the problem of efficient usage. As stated previously, this is a more complicated problem than generation. A very limited personnel is involved in the generation of utilities and, with proper instrumentation of the generating plant, the operation of the generating facilities can be checked readily. Any sources of waste easily are located and corrected.

However, the process operators who are going to take their power and steam requirements from the distribution systems are concerned primarily with obtaining the maximum yield of specification products from their respective operations. In order to achieve this objective, utilities in excess of those required for the most economical operation often are used.

Familiarize Operator with Cost of Utilities

One very effective way to reduce wastes of this nature is to make the operating personnel familiar with approximate costs of the various utilities such as steam, power, water, and compressed air. An educational program can be carried out by bulletin-board posters, personal contact, or some other suitable means. The information should be presented in such a manner that pounds of steam, kilowatt hours, or gallons of water readily can be translated into dollars and cents by the operators.

Competent Supervision of Utility Distribution

Constant supervision of the distribution and usage of utilities by competent personnel, working in cooperation with the operating forces, can do much toward decreasing the consumption of utilities used for process work. The supervising personnel should be thoroughly familiar with the processes involved, and should have the confidence and full cooperation of operating departments.

Without this supervision and cooperation, we might expect to find many situations where steam, power, or water is being used in excess of economical requirements. For instance, we may find that products are being cooled to lower temperatures than are necessary, requiring more water than should be used, or that more open steam is being used in a fractionating tower than is necessary.

Assume for the moment that an excess of open steam is used in a fractionating tower: Operating in this manner will require pumping additional water to condense the excess steam, additional pumping over the cooling towers—the capacity of which already may be limited—and additional makeup water to the cooling tower. Pumping this additional water requires an increase in power consumption. The increase in power consumption, however, will not be in direct proportion to the increase in water requirements. That part of the pumping head that is due to pipe friction will vary roughly as the squares of the velocities or rates of flow through a given system. Assuming that friction head was 50 ft. and that flow was increased 10 per cent, the new pumping head due to friction

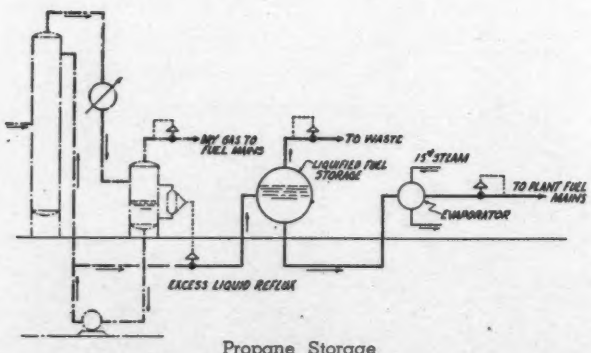
$$\left(\frac{1.10}{1.00}\right)^2$$

times 50 equals 60.5 ft, or an increase in friction head of 21 per cent.

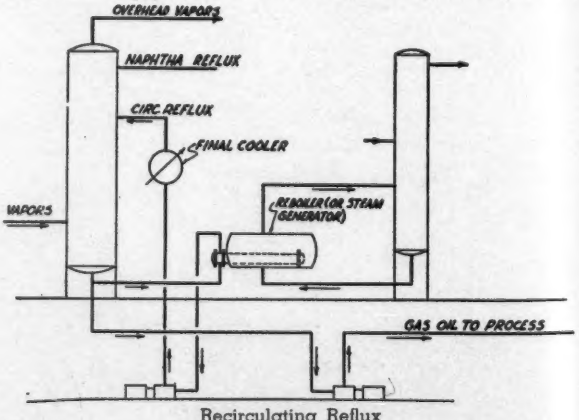
Thus, because steam in excess of requirements was used in a tower, it became necessary to use more water than should have been required, increasing makeup water to the cooling tower; and excess power was wasted handling the increased water requirements against higher heads than would have existed had the proper amount of steam been used.

Utilities Are Affected by Changes in Operations

All of us are familiar with the rapidity with which refinery processes change, due to the demand for new and improved products, the obsolescence of some processes, etc. These changes in operation often appreciably change utility requirements. At such times as process operations are changed, utility requirements should be checked closely to determine if existing systems economically will handle the new loads. Mechanical equipment on the process units affected should be checked to see if it is suited to the new operating condi-



Propane Storage
Figure 5



Recirculating Reflux
Figure 6

tions. By making proper modifications, much of the equipment may be adapted to the new load conditions.

It probably will be found also that, although other pieces of the available equipment could be used, it would not be economical to do so, because new equipment designed for the new operating conditions often will pay for itself in a short time, due to its higher operating efficiency.

Effect of Changing Operating Conditions on Centrifugal Pumps

As an example, a certain process as originally designed required 3,375 gal. per min of water at 100 ft. pumping head. Due to the installation of heat-exchange equipment, changes in charge rate, and other operating conditions, the condensing and cooling-water requirements were reduced to 2,500 gal. per min and the pumping head to 90 ft.

Water for the unit was supplied by motor-driven centrifugal pumps. The pumps were purchased originally to supply 3,375 gal. per min with 100 ft. discharge head. Motor speed was 1,160 rpm. The impelier diameter was 16 in.

In Fig. 2 we have shown the characteristic curves for the pump with the original 16-in.-diameter impellers.

After he had reviewed the new pumping conditions, the manufacturer advised that, by turning the original impeller down to 14½-in. diameter, the pump satisfactorily would meet the new conditions of 2,500 gal. per min against a discharge head of 90 ft.

The characteristic curves for the 14½-in.-diameter impellers also are shown in Fig. 2.

From an inspection of the curves it will be noted that we could have obtained the 2,500 gal. per min required with no changes whatever being made to the pump. However, the head, when delivering this capacity, would have been 114 ft.—whereas only 90 ft. was required. To pump the 2,500 gal. per min against 114 ft. head would require 83 brake horsepower. Now, by changing the impeller to 14½-in., the 2,500 gal. per min was delivered at a discharge head of 90 ft., requiring 65 brake horsepower, or a reduction of 16 hp. The power consumption would be reduced 21.7 per cent by installation of the 14½-in.-diameter impeller.

Steam-Turbine Water Rates

Steam-turbine nozzles are designed for maximum efficiency at a given steam pressure and steam flow. If original design conditions later should be changed to the extent that power requirements would be reduced appreciably, the nozzles would be working at a low efficiency, due to decrease in steam pressure in the nozzle ring or steam chest. A pressure gage should be installed on the nozzle ring, and design steam pressure maintained as closely as possible—either by hand valves to cut out some of the nozzles, or by renozzling for the new operating load.

As an indication of the magnitude of savings that might be made in this manner, a turbine originally installed to carry a 100-hp. load at 3,600 rpm. with initial steam pressure of 150 psi gage, 0 deg. superheat, and 15 psi back pressure required a water rate of 52 psi, or a flow of 5,200 lb. per hour. Due to a change in operating conditions, the load was reduced to 50 hp. at 2,850 rpm. Steam flow under these conditions was 3,540 lb. per hour. By installing a hand valve to cut out a number of nozzles and bring steam pressure up to the design point on the remaining nozzles, the steam flow was reduced to 2,960 lb. per hour, or a saving of 580 lb. per hour. This represents a saving of approximately 16 per cent. At 20 cents per 1,000 lb. of steam, this change would pay for itself in less than a month of continuous operation.

Scavenger Turbine Drives

Refinery steam and power balances are difficult to maintain, and at times considerably more low-pressure steam is available than is required for heating and processing. This often can be used to advantage for low-pressure condensing turbine drives. With steam at 10 psi gage and 24-in. mercury vacuum, water rates of 30 lb. per brake horsepower easily may be obtained in turbines of approximately 200 hp. Water rates of 40 lb. may be had on turbines of 60 hp. Considering the low-pressure steam as waste, the only operating expense would be condenser water and steam for the ejector.

Before installing the scavenger turbines, however, a study should be made to determine if the supply of exhaust steam more economically might be eliminated by motorizing some steam drives or changing some of the back-pressure steam drives to condensing operation.

Cleaning Water Lines

Power consumption required for pumping water often may be decreased appreciably by cleaning water lines. Pressure loss due to pipe friction should be checked periodically. When this loss becomes excessive, or the required carrying capacity of the lines is affected, the lines should be cleaned. Scaled or tuberculated lines normally can be cleaned mechanically with scrapers that are forced through the lines by water pressure.

In the following tabulation are given some data on a 10-in. line before and after cleaning. It will be noted that the friction loss before cleaning was 3.4 times as much as the theoretical loss for a 10-in. line having a "C"* value of 100; after cleaning, 1.3 times as much.

	Before Cleaning	After Cleaning
Total head, feet ..	165	142
Gallons per minute	830	1,200
Friction head, feet per 100 ft.	2.60	1.80
Theoretical friction head, feet per 100 ft.	0.76	1.40

*$S=\left(\frac{V}{1.318CR^{0.63}}\right)^{1.85}$, Hazen and Williams formula for friction loss in pipe lines.

Water Booster Pumps

A survey of water requirements often will indicate where savings in power required for pumping can be reduced. A study was made of the water-supply system in one plant, and it was found that, of the 8,000 gal. per min. being pumped against a discharge head of 185 ft., 6,000 gal. per min. could be used at 140 ft. head with some few changes. Only 2,000 gal. per min. was required at 185 ft. head.

Inasmuch as the water pumps were motor-driven, the impellers were turned down to deliver 8,000 gal. per min. at 140 ft. discharge head. A booster pump was installed to deliver 2,000 gal. per min., taking suction on the 140-ft.-head line and raising the head to 185 ft.

Power saving was:

8,000 gal. per min. at 185 ft. and 85 per cent efficiency=440 hp.
8,000 gal. per min. at 140 ft. and 84 per cent efficiency=336 hp.
2,000 gal. per min. at 45 ft. and 82 per cent efficiency=28 hp.
Horsepower saving=76 hp.

Insulation of Lines and Equipment

To keep insulation at its peak efficiency and save the maximum quantity of heat, insulation should be inspected periodically to make certain that it is weatherproof, fits surfaces snugly, and has not lost its efficiency due to extreme temperatures or damage from leaks in the surface insulated. This is very important on lines exposed to the elements or subject to severe vibration.

Reciprocating Steam Pumps and Steam Engines

The size of steam cylinders on steam-driven equipment should be watched closely, and kept to a minimum consistent with operating conditions. Steam consumption may be two or three times that actually required, if the steam-cylinder size is greatly in excess of that required.

(**Note**: The items discussed hereinbefore are only a few of the many that might have been mentioned whereby economies in fuel have been effected either in the generation or usage of utilities. They are, however, representative of the various ways in which the consumption of fuels used in a refinery, outside the refinery processes proper, may be kept to a minimum).

Savings of Fuels Used Directly by Processes

Hereinafter will be discussed some of the methods used to reduce fuel consumed directly in process operations.

Two-Stage Distillation on Solvent-Recovery System

Fig. 3 shows simple flow diagrams of two solvent-recovery systems. The left half of the figure shows an early design utilizing single distillation under 25 in. mercury vacuum and high circulating rates through the heater.

The flow diagram on the right shows a later design making use of two-stage distillation. Here the incoming mix charge is exchanged first against the vapors from the atmospheric section of the tower, and then against the vapors from the 40-lb. section of the tower, before going into the atmospheric section of the tower.

Approximately 40 to 45 per cent of the work is done in the atmospheric section of the tower. The 40-lb. section removes about 50 per cent of the solvent, and 5 per cent is removed in the stripper.

It will be noted that the average fuel consumption was reduced 47.3 per cent on this operation, due to the use of two-stage distillation.

Heat Exchange from Hot Streams

A typical flow diagram of a crude still is shown in Fig. 4. Another type of unit might have been shown, but this particular unit illustrates our point very well.

Briefly, the crude charge is passed through a series of heat exchangers in order to pick up heat in the crude charge, and at the same time cool the hot streams coming in from the tower. This has a twofold advantage: an attractive fuel saving is made, because we are recovering 46 per cent of the heat input to the crude charge; and, due to the cooling of the streams by the crude charge, cooling-water requirements are decreased appreciably.

Liquid-Gas Storage

The rate of gas production in a refinery is never exactly the same as the rate of consumption; and, unless some storage or surge capacity is provided, gas will be wasted during peak production periods, and fuel from some other source must be provided during the time that the production of fuel gas is less than the amount required for refinery operations. The excess gas can be stored either in gas or liquid form. Gasometers are used if gas is to be accumulated as such. If the gas can be accumulated in liquid form, this is usually more desirable, because much less storage space is required, and the gas can be released at sufficient pressure to go directly into the fuel mains. If stored in a gasometer, it has to be put into the fuel mains with compressors which require power or fuel consumption.

Fig. 5 shows one method of liquid-gas storage for balancing gas production and consumption. The particular process is a stabilizing plant. The excess reflux is accumulated in the pressure storage tank. So long as the plant fuel gas-line pressure is above a certain pressure, liquid gas is stored. However, as soon as the pressure drops below this set pressure, the regulating valve opens and gas is delivered to the fuel line through the heater and pressure-control valve. In this way the fuel gas-line pressure is maintained so long as liquid is available in the storage vessel.

Without this storage capacity it would be necessary to waste gas at such times as gas was being produced at a higher rate than it was being consumed; and when production did not meet requirements, it would be necessary to supplement the fuel supply with fuel oil, coal, coke, or probably gas purchased from an outside source.

The capacity of the storage ves-

sel, evaporator, and related equipment will depend, of course, upon the quantity of liquid gas available, fluctuation in production and consumption, and the duration of these periods.

With liquid storage, a vessel 5 ft. 0 in. in diameter and 27 ft. 0 in. deep will store approximately the same fuel value as a 250,000-cu.-ft. gasometer.

Heat Recovery from Recirculating Reflux

Fractionating towers often require large quantities of circulating reflux. The heat in this reflux must be absorbed in some medium, in order to do the required cooling in the tower. The heat could be removed by exchanging to water; but this serves no useful purpose, and would be at the expense of power expended in pumping the water required.

Fig. 6 illustrates how the hot reflux is used in a reboiler—replacing steam, and thereby saving fuel at the boiler house, besides making this steam - generating capacity available for other uses. Power for pumping the required amount of water also is saved.

Hot reflux might be used also to generate steam in much the same manner, and this would reduce also the quantity of fuel required at the boiler house. There are many such installations that have been in satisfactory service for long periods of time.

Conclusion

There are, of course, many other ways in which fuel consumed by the processes might be reduced; but the examples cited serve to illustrate the possibilities that exist. A study of the various processes in use, no doubt, will present other ways in which fuel requirements may be reduced.

William B. Robb Dies in Bakersfield

Funeral rites were conducted in Bakersfield, Calif., for William B. Robb, Mar. 26, and cremation followed at Bakersfield Memorial Park.

A pioneer oil operator in Kern County, Mr. Robb, secretary of the Independent Oil Producers Agency since its inception and L. P. St. Clair, former president of the Union Oil Co., developed the Kern River oil field, one of the first major oil fields in the county.

He was born in Nova Scotia and came to Kern County in 1901. He was a member of the Kern County Union High School board of trustees from 1929 to 1934, a director of the Independent Petroleum Association of America, a member of the Elks Lodge No. 266, Bakersfield Rotary Club and Knights of Pythias and A.P.I. Well known in oil circles throughout the country, he was listed in the National Who's Who.

Honorary pall bearers were L. P. St. Clair, Arthur S. Crites, Alphonse Weil, Judge T. N. Harvey and Frank Estribou. Survivors include his widow, Mrs. Maude Robb of Bakersfield; two sons, William B. Robb of New York and Lieutenant Stewart W. Robb in the army air corps; two daughters, Miss Hazel Amelia Robb of Bakersfield and Mrs. Kenwood Harrison of Quincy; three sisters, Mrs. George David Stewart of New Jersey, Mrs. O. J. Wilsey of New York and Mrs. James McKinley of Glendale.

An Eye TO THE FUTURE

INDUSTRIAL CHEMISTRY has established for itself, through actual accomplishment, the reputation of keeping "an eye to the future."

As evidence of this fact Great Western Division, The Dow Chemical Company foresaw an unprecedented demand by West Coast industry for chemical products manufactured in the west. Additions to the two Great Western West Coast plants started two years ago are now in operation.

Nevertheless, with shipping facilities at a premium, coupled with the unprecedented demand for strategic chemicals in our defense effort, even these increased production facilities are not equal, immediately, to cope with the current abnormal demand.

True to tradition established by industrial chemistry Great Western is rushing to completion plans previously made for further expansion and better service.

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Largest Spark Plug Rig Reveals Value of Hydraulic Couplings

By Edward Timbs, Chief Engineer
National Supply Co.

Deep drilling is now being accomplished with drilling equipment using internal combustion engines, fuel being Gas, Butane, Gasoline or Diesel Oil. This type of power, although more economical, does not have the smoothness and flexibility of steam. Therefore, to obtain as near as possible the steam engine characteristics it has been necessary to introduce some cushioning device between the internal combustion engines and the power transmission shafts. For this purpose, engineering skill has been for many years developing and applying the principle of Hydraulics, and today we have available proven equipment to meet this important necessity. The drilling rig to be described is the largest "Power Rig," or "Spark Plug Rig" as sometimes called, designed and built for deep drilling and incorporates Hydraulic Couplings to flexibly engage the power from each of the engines to the drive shafts to supply the total power available for the draw works and mud pumps.

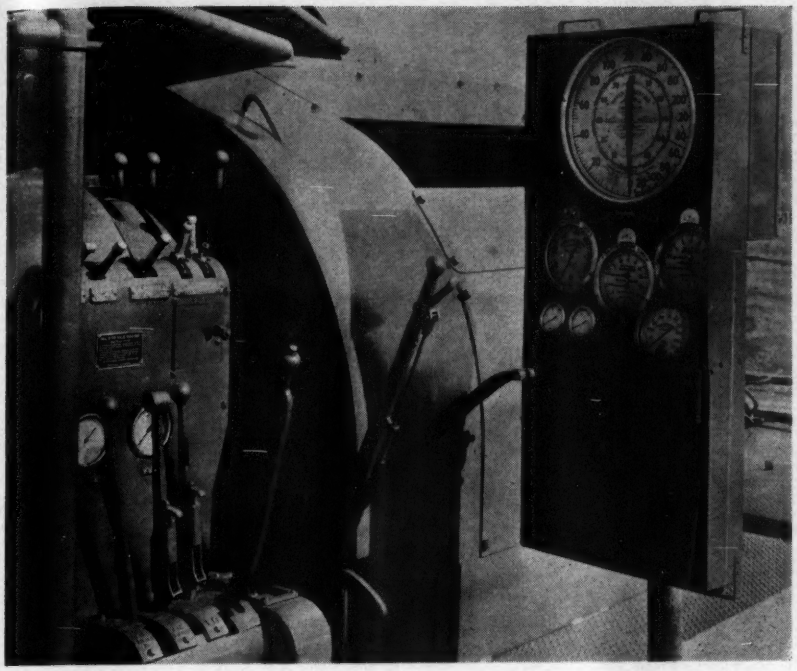
This rig consists of a National Type 125 Consolidated Rig, with 4—Waukesha Engines and a National Type C-350, 7¾ x 18 Power Pump hooked up to the rig proper.

Separate from the main portion of the rig is an independent pump unit consisting of one National Type C-350, 7¾ x 18, and one C-250, 7¼ x 15 Power Pump hooked up to two Waukesha Engines each with their drive equipment mounted on the engine skids.

Portable steel mud tanks with mud shakers are included in this arrangement. The mud lines to and from tanks and pumps are assembled so that the pumps may be operated either with straight discharge to drill pipe, or compounded through the second C-350 pump when higher fluid pressures are required. Also, when greater volume of mud is required, both C-350 pumps can be operated in parallel so that the combined fluid capacity of both pumps can be discharged to the drill pipe.

The draw works unit is a National

The giant spark plug rig consists of a National Consolidated Rig, with 4 Waukesha Engines and National 7¾x18 power pumps.



Controls are hand operated air valves governing the master clutch, primary drive clutch, and empty block and rotary clutch.

Type 125 which has a hoisting capacity of 680,000 lbs. when using 8-line reeving and line speeds from 270 to 3150 feet per minute, plus an extra high line speed of 3900 feet per minute for handling empty blocks. This Type 125 Consolidated Rig is rated for 12,000 to 13,000 foot drilling with safety.

This draw works is of sturdy construction, and as well as being streamlined, embodies the very latest and safest operating equipment. Compressed air power is employed to engage the heavy duty friction clutches, making a very flexible, easily operated and accessible heavy duty hoisting unit. A sand reel or core reel is an integral part of the draw works having the same number of speeds as the main drum.

Draw Works powered by multi-cylinder internal combustion engines require more selective speeds for the hoist than would be required with steam power. Therefore, this Type 125 Rig has six regular hoisting speeds, also two additional independent high speeds for hoisting the empty elevator at a safe high speed without changing gear and racing the engines. All of these hoisting speeds are directed to the drum by the engagement of air operated friction clutches.

The unique design of selective chain transmission built into this draw works makes available six speeds for the rotary drive so that a Bit speed best suited to the formation encountered can be used.

The draw works separates into two units of unrestricted width for convenience in transporting.

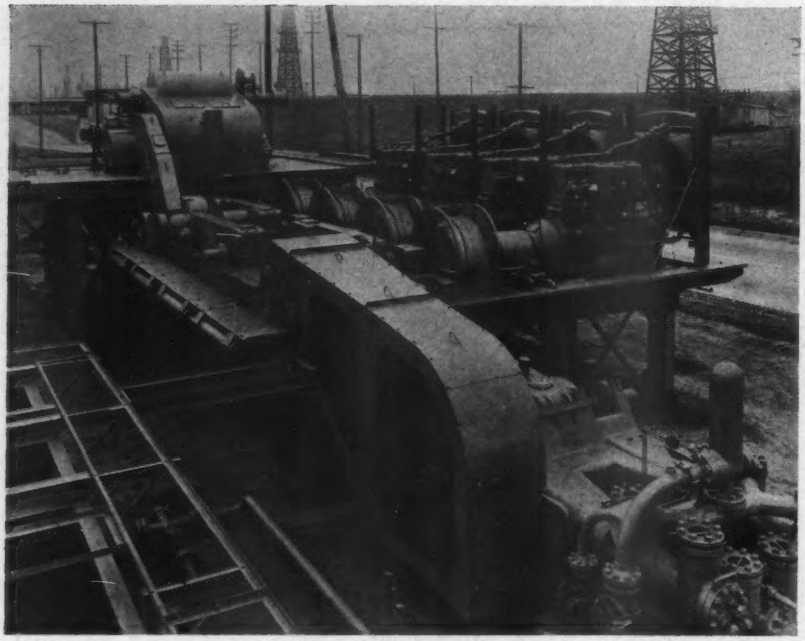
A Parkersburg 40-inch double rotor hydromatic brake is assembled to the frame and is clutched to the drum shaft by a sliding gear tooth connection so that the hydromatic brake can be engaged when "running in" the drill pipe and remaining at rest when not needed.

When coming out of the hole, all or several of the six speeds of the primary drive may be used progressively for hoisting operations. The drive on the side opposite the driller is then coupled to the rotary drive sprocket for the usual rotary machine operations of "rotating out."

A reverse through the use of helical gears is incorporated in the three shaft, six speed chain transmission forming the rear half of the draw works. It can be readily understood that with the use of compressed air for the operation of the Master, Primary, "Empty Block" and Rotary Drive Friction Clutches, all operations are performed with a minimum of effort. By the use of gear tooth clutches on the line shaft and drum shaft, sliding clutch keys have been eliminated on the principal drives giving increased strength to the shafts. The sprockets on these shafts are mounted on roller bearings, thus maintaining true alignment of the sprockets and eliminating shaft wear.

The controls which are all conveniently located are the hand operated air valves to control the master clutch, primary drive clutch and empty block and rotary clutch. Engine throttle control hand levers which are on the same panel as the clutch levers can also be actuated by a foot pedal. Manual shifting levers for engaging the selected drive in the transmission are located directly in front of the control panel. Controls for cat shaft and sand reel are just above the control panel. The sand reel brake lever is located adjacent to the drum brake lever. This draw works is shown fitted with a Foster Catline Hoist and a Foster Hi-Speed Cathead.

The draw works power plant located a few feet below the derrick floor and supported on a sturdy structural steel support, made in sections for ease of transporting consists of four Waukesha Hesselman 282 horse power engines, each engine being direct connected to a drive shaft through a Hydraulic Coupling. All of the engines are arranged in a straight line, and each of the engine and shaft assemblies is mounted on heavy steel skids for easy transporting. Upon the drive end of the engine skids is located the four engine chain transmission which is also a complete assembly on a heavy steel frame and can be hauled in one piece. These sprocket chain drives completely enclosed are the means of compounding all four of the engines and transmitting their combined power to the draw works, or combining the power of the first two



The Consolidated rig is rated for 12,000 to 13,000-foot drilling with safety. Note the streamlined appearance.

engines to the draw works for rotary drilling operation, and at the same time, have the combined power of the second two engines to operate the C-350 mud pump. Any one of these engines can be cut out from the drive in case the total power is not required, or while making adjustments on the engine without interfering with the normal operations.

On the engine shaft directly in back of the draw works there is a Vee-Belt drive to a two stage air compressor, which with its air receiver, is mounted on the chain drive compound unit. This compressor supplies the power for operating the various clutches on the draw works. The engine shaft farthest from the draw works is fitted with a friction clutch Vee-Belt roller bearing pulley for driving the C-350 power pump, in addition to the sprocket for the drive to the next engine. These drive units, like the draw works, have their parts requiring lubrication completely enclosed in oil tight housings and other moving parts guarded for safety. The chain drives are kept thoroughly lubricated by an oil circulation system operated from the engine shaft nearest to the draw works. The Vee-Belt drive to the mud pump is equipped with an adjustable idler pulley so that the correct tension can be maintained on the Vee-Belts without moving the pump. The equipment between the engines and the chain drive transmission is the engine power take-off clutch, the Hydraulic Coupling and Coupling Oil Coolers.

The Hydraulic Couplings are located between the prime movers and the drive shaft. Since their introduction for drilling equipment application a few years ago, the operators are fast becoming aware of the advantages of their use in connection with rigs of this type.

The type of Hydraulic Coupling used on this rig is one in which the output speed and power is controlled by means of a scoop tube, which by manipulation from an outside lever, can be set in any position from full dip to fully retracted. The Hydraulic Coupling consists fundamentally of three main elements,—the impeller, the runner and the enclosing cover—plus an outer rotating oil reservoir, a fixed manifold and the adjustable scoop tube. With the control of the scoop tube from the outside, the amount of oil required to pass through the working chamber to give a determined amount of power and speed is picked up by the scoop from the outer rotating reservoir. The impeller which is formed in the cover is attached to the engine shaft and the runner to the driven shaft. The impeller and runner are radial-vaned, but not in actual face contact with each other, and are so arranged that the impeller delivers its kinetic energy to the runner at a constant torque. The scoop when set in any of the various positions changes accordingly the amount of power to be delivered to the driven shaft. The control of the coupling power and speed output is particularly important when fishing, and very essential when compounding the slush pumps. The Hydraulic Coupling is a complete assembly having its own roller bearings, and with the flexible couplings connecting it to the engine and drive shaft it can be lifted out without disturbing the balance of the equipment. The light oil used in the Hydraulic Couplings is cooled by water passing through a bank of heat exchangers which are mounted in the engine skids and connected to the manifold of the coupling. The water after passing through the oil coolers can be returned to the line after passing over a water cooling tower. (Separate water pump unit is usually used to assure proper amount of water going through coolers.)

The Slush Pump unit which operates entirely independent of the draw works consists of two Waukesha Engines, of the same type and size as used on the draw works, mounted on steel skids and connected to drive shafts through the same size scoop control Hydraulic Couplings as used on the main rig. These power units are for driving a C-350, 7¾ x 18, and a C-250, 7¼ x 15 Power Pump and are arranged so that the power of both engines can be supplied to the larger pump. The smaller pump is hooked into this drive so that mud conditioning operations may be carried on with this pump having ample power from one of the engines.

The engines of this pump unit compound their power to the larger pump through a Vee-Belt drive fitted with a friction clutch. The Vee-Belt pump drive pulleys are also equipped with Twin Disc type friction clutches and adjustable idler pulleys. The Hydraulic Couplings are used with this unit not only to save considerable wear and tear of the engines, but to balance the performance of the C-350 pump when operating in conjunction with the other C-350 pump driven from the draw works engines when the mud pressures required are to be high enough to make it necessary to compound the pumps.

Before the arrangement and material used in this rig were decided upon, the Superior Oil Company gave considerable thought to the possibilities of rigging up and tearing out at each location with a minimum amount of labor and a saving of material, as well as convenience in transportation. This is accomplished by rigging up all units including derrick, sub-structures, mud boxes, and power pumps from the same accurate grade level and also located from the center line of well.

The mud lines and pump manifolds are connected with unions so that same can be disassembled into lengths not more than 20 feet. Two stand pipes and mud lines to derrick floor are interchangeable, large radius turns are used to prevent cutting from mud stream.

The main pump manifold is located and anchored on the ground to minimize vibration. The discharge connections are equipped with ball joint unions and the suction lines with 10-inch rubber hose to permit locating the pumps for initial belt tension without disturbing the rest of the piping. This manifold is equipped with an emergency "By Pass" line.

All 3-inch and 4-inch valves are of the flange type to facilitate replacing.

The C-250, 7¼ x 15 pump manifolding is arranged to take care of mixing mud or weight material and transferring between tanks and to the well.

Joint Operators Start Mendota Area Outpost

Jergins Oil Co. and Superior Oil Co. are rigging up to drill Cheney Ranch No. 3 approximately a mile northwest of the two tests drilled by the former from 1939 to 1941. Located in the northwest corner of sec. 30,14-13, the project is scheduled to core the Domengine section of the Eocene which the Jergins wells found near 4460 ft. The earlier development in effecting some gas and condensate production from the Cretaceous near 7000 ft. was never considered as commercial but rather an indication that substantial production might be found elsewhere in the area.

Engineering, Technology, latest news—twice a month in California Oil World.

NO. 2 HOW BOWEN TOOLS CONSERVE COSTLY WELL EQUIPMENT

A LINER HANGER

that won't slip down the well

In these days—with pipe at a premium—it's mighty good to know a Bowen Hanger is supporting the liner in your well.

For one thing, this easy-to-set tool gives *positive liner suspension* that prevents slippage, greatly reducing chance of the liner buckling, breaking or collapsing in the well.

Another advantage: If you want to remove the liner all in one piece for re-use in another well, or for installing again after re-drilling, the Bowen Hanger can easily be released and brought to the surface. This leaves the way clear for liner removal and further conditioning operations.

Plain, pack-off and hydraulically-set types of Bowen Liner Hangers are available in all popular sizes for all installations. Phone your nearest Bowen Service Store—or write direct.

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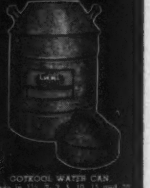
GOTT Water Coolers are the convenient way to keep drinking water handy to the worker, protect it from impurities. Their exclusive construction keeps water cool for long periods. Snug fitting large removable top, handy non-leaking push button faucet. GOTT Water Cans for handy field use. Your Supply Store has them, get one today!



H. P. GOTT MFG. CO.
WINFIELD, KANSAS

GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. Furnished with push button faucet or slight additional cost.

KEEP PURE DRINKING WATER ALWAYS HANDY

Thermal Logging

(Continued From First Issue, March)

The temperature of the fluid opposite Zone 2 on both runs is the same because no production was coming from this zone. A flowing pressure traverse indicated a water gradient from the bottom of the tubing to the bridge plug.

In order to secure a temperature anomaly from gas entering a well on a flowing run where the tubing extends below the producing area it is necessary to produce the well between the tubing and the casing. The same temperature anomalies that occur outside the tubing will then be observed in the static fluid in the tubing.

Establishing Point of Production

The thermal log reproduced as Figure 3 shows that the well is producing from the top few feet of a perforated interval. The flowing gradient to the point where the curves diverge is 0.8° F. per 100 feet while the shut-in gradient is 2.3° F. per 100 feet, which is the slant of the geothermal gradient for the field. If the production had been coming from lower in the perforations the divergence of the curves would have been from the lowest point that production was entering the well. Where there are several perforated intervals in a well the divergence of the two curves will indicate the lowest interval that is producing.

Tracing Migration of Fluid

During the life of a field where wells take in two or more zones there is apt to be considerable migration of fluids from one zone to another due to uneven withdrawals. In Figure 4 the tubing is packed off between two zones. These two zones produce oil of different gravity. Normally producing through the tubing from the lower zone, the well started to make oil from the upper zone. The temperature traverses were made to determine the condition of the well. Both the flowing and shut-in temperature curves are considerably below the geothermal gradient. Normally, the shut-in gradient should approach the geothermal gradient, but the reverse condition exists. The results indicated a migration of gas and oil from the upper zone to the lower part of the second zone with no evidence that the packer had failed. The lower temperatures on the shut-in run suggests that more fluid was migrating downward while the well was shut in than while the well was flowing. A plug was run to the bottom of the tubing and the well continued to produce. Attempts were made to set the slips on the plug between 3100 and the bottom of the tubing, but the volume of fluid moving downward prevented the slips from taking hold. At 3100′ it was possible to set the plug, which indicated the hole in the tubing was at 3100′. A short sleeve was placed in the tubing at this point and the well was returned to production. A change in the gravity of the oil to that of the lower zone showed that the repairs were successful.

Locating Holes in Casing

A method of locating holes in casing that has proved successful is shown by the results of a single traverse made in a well, Figure 5. In this well 11¾″ casing was set at 5464′ and the 8⅝″ casing was set at 6980′. The tubing extended into the liner below 7000′ and was shut in at the surface. A portable compressor was moved to the well and gas was injected between the 11¾″ casing and the 8⅝″ casing through the holes in the latter, returning to the surface through the annulus between 8⅝″ casing and the tubing. Some fluid also was being produced between the 8⅝″ casing and the tubing.

After the fluid had been depressed by the injected gas to a point below

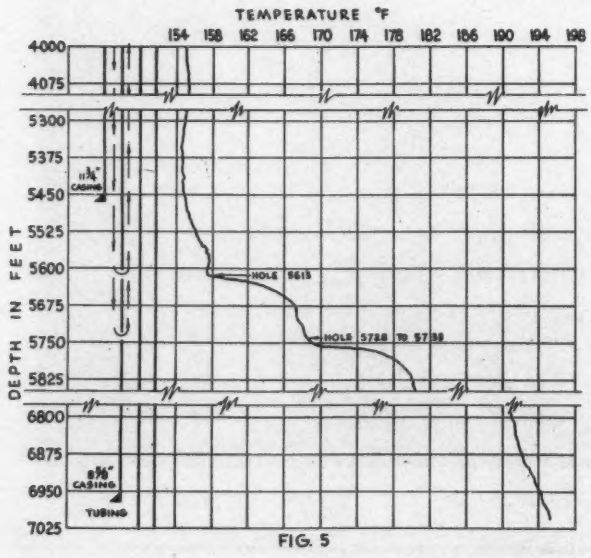


FIG. 5

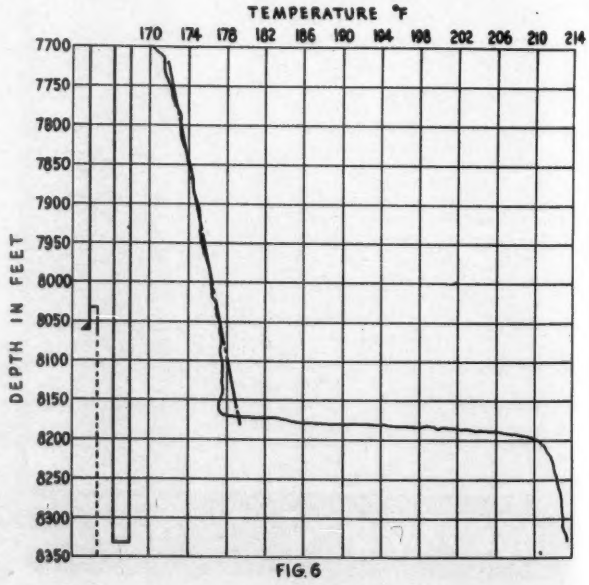


FIG. 6

the holes in the 8⅝" casing the injection pressure dropped. The temperature recorder was then run in through the tubing and the traverse was made from 4000′ to 7000′. Between 5615′ and 5620′, and between 5735′ and 5750′, sharp increases in temperature are shown as the gas passed through the holes into the fluid inside of the 8⅝" casing. The tubing was pulled and a double packer was run in. The area was tested and a hole was found at 5613′. Circulation through the hole was established with a pressure of 2500 lbs. and 2 cubic feet of water per minute was circulated through the hole. The area from 5725′ to 5775′ was tested on two separate runs with the double packer but the hole indicated by the thermal log was not found. A third attempt proved successful and a hole was found between 5728′ and 5739′. Circulation was established through the hole and 0.8 of a cubic foot of water per minute was circulated at a pressure of 2500 lbs.

The thermal log with gas injection can also be used under certain conditions to locate holes in tubing, or holes between any two strings of pipe.

Testing Gas Injection Wells

In gas injection wells knowledge of the area taking the gas is important. Figure 6 is a thermal log made in a gas injection well. The traverse was made through the tubing which was landed near the bottom of the well and the gas was being injected through the annulus between the tubing and the casing. The fluid was depressed to 8170′ by the injected gas and a change of gradient from the top of the perforations to the fluid indicates the formation through this area was taking the gas.

Conclusion

Many useful applications for precision temperature measurements in oil wells exist, and others will be found as work of this nature is continued. In this brief paper it is not possible to set forth all of the applications and limitations of thermal logging to producing wells, but the examples given illustrate a few of them and will serve to suggest many others. Thermal logs assist in securing better performance of the wells. The data can be obtained with a minimum of equipment; no great amount of time is required for the field work; interpretations can be made according to established principles. The continuous film record that is magnified many times as it is transferred to chart paper, without error in the record, opens up new possibilities in thermal logging and many other types of precision measurements made in oil wells.

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3 C. V. Millikan: Temperature Surveys in Oil Wells. A. I. M. E. Technical Publication No. 1258, (1940).

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Make No. 1—Prior to running a string of Axelson sucker rods, make No. 1 parted EIGHT TIMES in the well, proving costly in money and production time.

Make No. 2—On this same well, competitive sucker rod No. 2 replaced make No. 1 one month later and remained in service 5 months. Rod parted SIX TIMES during this period with additional time and money losses.

In one year, prior to the installation of Axelson rods, the combined total No. 1 and No. 2 rods parted in the well, was 14 TIMES. THEN the production superintendent switched to Axelson. After a year of service Axelson sucker rods have continued to give economical and satisfactory operating service. Think how much this company could have saved had they installed Axelson originally. It will pay you to call your nearest Axelson representative right now and get complete information. Send for illustrated book, "Not How Much But How Well". It will prove to you why Axelson Sucker Rods are bound to perform better.

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SELLS AND SERVICES DEEP WELL PLUNGER PUMPS AND SUCKER RODS

P. H. Patchin Elected Standard Vice President

Election of Philip H. Patchin to be a vice-president of the Standard Oil Co. of California follows an extensive career in journalism, public relations and diplomacy and long service in the oil industry.

P. H. Patchin

As a New York newspaperman and war correspondent, Mr. Patchin saw service in many parts of the world. During the earlier part of World War No. 1 he was stationed in London, the focal point of news from the Allied front. Upon the entrance of the United States into the war he returned to this country to serve throughout the remainder of the conflict as public relations representative of the State Department, and attended the peace conference as a secretary of the American Peace Mission. After coming to the Coast he was again summoned to Washington in 1922 to take charge of public relations of the American delegation at the disarmament conference.

In 1919 Mr. Patchin became connected with the Standard Oil Company of California and shortly thereafter was appointed assistant to President K. R. Kingsbury. In July, 1935 he was elected to the board of directors of the company.

Columbia Steel Expanding Plants

Columbia Steel Co., subsidiary of United States Steel Corp., on April 1, announced additions and improvements to its Pittsburg and Torrance, Calif., plants which will increase materially their production of steel for the nation's war effort. The expansion program, which will provide additional open hearth and electric furnace capacity as well as alterations and improvements in finishing facilities, will be undertaken entirely with the corporation's own funds at an estimated cost of $8,500,000. The installation will be completed with all possible speed.

The additional expansion of Columbia's steel-making facilities will complete U. S. Steel's part, amounting to more than one-third, in the 10,000,000-ton steel ingot expansion program recommended last year by Government defense authorities.

These new U. S. Steel facilities, the major part of which are being built at the expense and for account of the Government, embrace, in addition to the Columbia Steel program, vast new iron and steel producing facilities in the Pittsburgh, Pa., and Chicago, Ill., Districts, and the construction of new iron and steel producing and finishing facilities in Utah and California. In addition, United States Steel Corp. has numerous other projects providing substantial additions and improvements to its manufacturing facilities in various localities to meet war-time demands. Work on these various projects is rapidly going forward.

Worthington Pump Appoints J. T. Wright

The appointment of Joseph T. Wright as manager of the Compressor and Tool Division at its Holyoke, Massachusetts, Works is announced by Worthington Pump and Machinery Corp.

Mr. Wright has had a broad experience in the machinery field. He served as assistant works manager of Lodge and Shipley Machine Tool Co. during World War I, subsequently organized J. T. Wright Co. of Cincinnati for the manufacture of paper drilling machines and other special equipment. This organization subsequently merged with Harris-Seybold-Potter Co., Dayton, Ohio, with which organization Mr. Wright served in several responsible capacities.

N. J. Allen Resigns From Lincoln Pete.

N. J. Allen, for fourteen years secretary and controller of Lincoln Petroleum Co., has resigned effective Apr. 30. Mr. Allen intends to take a short vacation before taking up further business activities.

Newest San Francisco downtown service station of Tide Water Associated Oil Co., located at the corner of Mission and New Montgomery Sts., offers parking facilities for 115 automobiles, 44 of which are parked on the roof. Associated's President William F. Humphrey (left) personally served the station's first customer, T. A. Brooks (right) San Francisco's City Administrator, while P. E. Allan, general sales manager of the company looked on.

D. G. Follis Follows Standard Tradition

D. G. Follis, who was recently elected a director of the Standard Oil Co. of California, first joined the company in February, 1918, as office

D. G. Follis

boy, after which he worked as rotary helper at Elk Hills from January 1919 to October 1919. Later he attended the University of California and Princeton, graduating from the latter in 1924. In September, 1924 he entered an 18 year period of uninterrupted company service that was to embrace all phases of modern oil refining, beginning with two years of basic experience at the Richmond, Calif., refinery as engineer's helper, special operator and specialist in the varied operations there.

In 1926 he became assistant superintendent of the Bakersfield, Calif. refinery, and in 1928, superintendent of the Pasotex Refinery at El Paso, Texas. Between 1932 and 1937 he held the positions of assistant to the chairman of the Manufacturing Committee, at San Francisco; vice-chairman and secretary of the Manufacturing, and manager of the Cracking Plant, first named the "Pressure Division".

In 1937 he became assistant to the general manager of Manufacturing, and on Jan. 1, 1940 he was appointed general manager of that department, a position which he still retains as a board member.

H. L. Painter Goes To Balboa For Union

Appointment of H. L. Painter as division sales manager for Union Oil Co. in Central America has been announced by A. C. Stewart, vice-president and sales manager of the company. Mr. Painter recently left Los Angeles for Balboa, Canal Zone, where he will establish headquarters.

Formerly in charge of the company's Industrial Sales Promotion program Mr. Painter has been associated with Union Oil since 1927.

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DEFENSE
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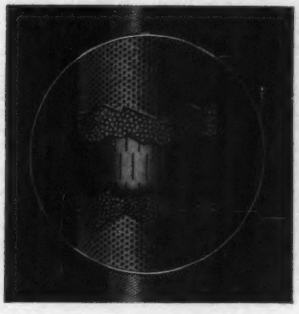

Of course you are! Sand wears out pumps . . . cuts and weakens liners . . . reduces production . . . causes needless and costly well maintenance!

And there is an effective, profitable way to fight sand wherever it causes these production problems — *install Pacific Pre-Packed Gravel Liners!* Because of their round, smooth *sheet steel* construction and uniform gravel pack (selected to fit *your* conditions) these liners insure years of trouble-free sand control. The outer screen actually has *more* open area than wire mesh. It won't tear on obstructions when installed, it holds the gravel uniformly around its entire circumference, and it gives rigid support in the well against liner sag or collapse. All-welded single sheet construction makes the screen nearly as strong as solid pipe and thus insures easy and *safe* installation.

Pacific Pre-Packed Gravel Liners come in all sizes and lengths, and are made in wrought iron, Armco ingot iron or cold rolled alloy steel to meet every well requirements—in any field. Phone—or write — for more detailed information *today* . . . and ask also about Pacific's specialized pipe perforating service for fabricating liners to *your* specifications.

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THIS

LAUGH

OFF!!

"Doctor, how do you tell if a person is insane?"

"Oh, we merely ask him a few ordinary questions which ordinary people can answer correctly."

"What type of question?"

"Well, this is the sort of thing: Captain Cook made three voyages around the world, and died on one of them. Which was it?"

"I think that's a bit steep. I'm not very good at history."

Mother: "Daddy and I won't be home tonight, Johnny. Do you want to sleep alone or with nursie?"

Johnny (after some deliberation): "What would you do, daddy?"

Then, there's the story of the gent leaving his club slightly the worse for wear. Turning into the main highway he decided, in his alcoholic daze, that the safest procedure was to keep his eyes glued on the car ahead and follow it closely.

This he did for some time and he was just congratulating himself on his sagacity when the car ahead suddenly stopped and he crashed into it with a loud bang.

The irate driver of the first car stuck his head out of his window and glared back angrily. "What's the big idea?" He bellowed. "What's the big idea?" the drunk retorted, "why didn't you stick out your hand?"

The other driver's eyes opened wide with astonishment. "I didn't think I had to do that in my own garage!" he yelped.

A father surprised his eleven-year-old with a bike for his birthday. Mother and father watched proudly as the boy rode round and round the block. On his first circuit he called "Hey, mom, no hands." Going past the second time, he shouted: "Hey, mom, no feet." The third time around, "Hey, mom, no teeth."

"But I can't pay you for this suit for three months."

"Oh, that's all right. Don't worry about that."

"Well, thanks. When will it be ready?"

"In about three months."

Two salesmen met in a Pullman after not seeing each other for three years. "Jim," said one of them, "the defense program is speeding everything up but you still talk just as slow as ever."

"Well," said Jim, "if — you — think — I talk — slow — you — should — hear — my secretary. She — had — a date — the — other — night — and — her — boy friend — parked — on the — way — home. And — before — she — could — say — I'm — not — that — kind — of — a — girl, — she was."

A young lady with a touch of hay fever, took with her to a dinner party two handkerchiefs, one of which she stuck in her bosom. At dinner she began rummaging to right and left in her bosom for the fresh handkerchief. Engrossed in her search, she suddenly realized that conversation had ceased and people were watching her, fascinated.

In confusion she murmured, "I know I had two when I came."

Jones: "Here's that last pair of trousers you made for me. I want them re-seated. You know, I sit a lot."

Tailor: "Yes, and I hope you've brought the bill to be receipted. You know I've stood a lot."

"Fred, there's someone creeping upstairs."

"Whazza time?"

"Half-past three."

"Well, thank goodness, it's not me this time."

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A FIELD PROVEN METHOD OF EQUALIZING V-BELT TENSION! INSURES LONGER LIFE TO V-BELTS AND PULLEYS! AFFORDS FULL PROTECTION FROM SLIPPAGE!

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Field Development

Los Angeles Basin

Mangold & Morse Well Temporarily Suspended

Pending a reorganization, Mangold & Morse Oil Co. has suspended drilling its Castaic wildcat McDermott No. 1 in sec. 26,5n-17w. Bottom is at 4315 ft. in the Mohnian member of the Middle Miocene which at this point shows 12° dips.

In the Saugus area, Roy W. Young, Inc. Walker No. 1 is drilling in silty gray shale at 8520 ft.

La Bolsa Rancho Well Is Wet on First Test

La Bolsa Rancho Oil Syndicate's Crane No. 1, located at the intersection of Wintersburg and Springdale Roads northwest of Huntington Beach, was last reported as swabbing water with only traces of oil and gas. The hole was drilled to 6956 ft. and plugged to 6750 ft. where casing was cemented and gun-perforated in three intervals below 6510 ft. The sands are said to be stratigraphically comparable to the Lower Ashton zone of Huntington Beach.

Rio Hondo Wildcat Plans Production Test

Potrero Oil Co. is planning to set casing for a production test of Newman No. 1, wildcat project located near the Rio Hondo north of the east end of the Montebello field. The decision to run pipe was made after taking wall samples of electric log showing below 5030 ft. Total depth of the hole is 5430 ft. but it is plugged to 5300 ft. above a drill collar fish.

Majors Schedule Orange Co. Wells

Two major companies are planning to drill test wells in Orange county in the near future in search of oil accumulated in stratagraphic traps in the easterly portion of the Los Angeles Basin. The Texas Co. which obtained small production in Spencer No. 1 southeast of Buena Park will drill two wells simultaneously, one to the southeast and one to the northwest, both of which will be virtual wildcats because so little is known of subsurface conditions. Necessity for regrouping leases to conform to "M-68" specifications has delayed the starting of both projects.

Next company to drill in Orange county will probably be Richfield Oil Corp. which has accumulated leases totalling several thousand acres in the vicinity of Santa Ana. Because of the cost of lease rentals here it may be assumed that a well will be started in the very near future.

Universal Testing Deep Aliso Project

Universal Consolidated Oil Co. is making a water shut-off test in Ward No. 1 at Aliso Canyon preparatory to making a production trial

LOS ANGELES BASIN WILDCATS

Area	Well	No.	Section	Depth	Status
Castaic	Mangold & Morse Oil Co., McDermott	1	26, 5-17	4315	Idle
	Young, Roy, W., Inc., Walker	1	11, 4-16	8519	Drilling
La Mirada	The Texas Co., McNally	A-2	15, 3-11		Rigging Up
Newhall	Airline Oil Co., Perkins	1	11, 3-16	2610	Idle
Palos Verdes	Surety Holding Co.	1	22, 5-14	1480	Idle
Puente Hills	Axis Pet. Co., Tandberg	1	13, 2-11	4189	Idle
	Axis Pet. Co., Rowland	1	21, 2-10	2468	Water well
	Continental Oil Co., Turnbull	3	13, 2-11		Location
	Lytle, Robt. S., Opr., Central	1	15, 2-11		Rig
Rio Hondo	Potrero Oil Co., Newman	1	32, 1-11	5430	Rec. fish
San Fernando	Fernando Oils, Ltd., Chatsworth	1	18, 2-16		Rig
	Shell Oil Co., Mission	2–1	25, 3-16	6831	Drilling
	Tide Water Assoc., Mission	1	26, 3-16	9291	Swabbing
	Tide Water Assoc., Sesnon	1	28, 3-16	6036	Testing
Whittier-La Habra	Los Nietos Valley Oil Co., Woodard	1	29, 2-11	50	Idle
	Orange County				
Anaheim	The Texas Co., Byington	1	6, 4-10		Location
Bolsa Chica	La Bolsa Ro. Synd., Crane	1	22, 5-11	6956	Swabbing
Costa Mesa	Thompson, Milton N., Banning	1	9, 6-10	5649	Fishing D.P.
Cypress	Midfield Pet. Co., Cypress	1	16, 4-11		Location
Kraemer	South Basin Oil Co., Well	103	24 3-9	2683	Drilling

of a newly found deep sand. Finding the Porter No. 12 sand too tight to produce at 7600 ft., the well was deepened to find a zone at 8733 ft. which showed enough promise to deserve a test. After prospecting ahead to 9361 ft., a plug was placed at 8850 ft. and a liner containing 112 ft. of perforations was landed and cemented through perforations at 8730 ft.

In the proved section of the field, Tide Water Associated Oil Co. is preparing to spud Porter No. 4 which is scheduled for completion in the 5000 ft. zone.

Kraemer Wildcat Nears Objective

South Basin Oil Co.'s important East Richfield wildcat, Well No. 103 on Kraemer property in sec. 24, 3s-9w, is drilling and spot coring below 2850 ft. and should reach its first objective sands at approximately 3000 ft. Located east of the Repetto pinchout, the well passed from Pico to Puente between 2400 and 2560 ft. Core dips have flattened considerably in the last few hundred feet and were last reported at 9°.

W. Gulf Abandons Oak Canyon Well

Western Gulf Oil Co. failed to find production in the redrilling of Lechler No. 3 at Oak Canyon and is now abandoning the hole. Located west of No. 2 which discovered the deep zone and north of No. 1 which found production in the shallow sands, No. 3 was drilled vertically to 7595 ft. topping the barren deep sand at 6692 ft. The hole was then plugged to 2100 ft. and redrilled whipstocking to the southeast. In the second hole the sand was encountered at 7032 ft. and though the top showed a little oil, the well was abandoned at 7060 ft. without a production test. Lechler No. 3 appears to definitely mark the northwesterly limits of the Oak Canyon field.

In part, at least, compensating for the failure of Lechler No. 3 is the south easterly extension well L. W. Gilmour-U. S. No. 1 which should push proved limits 1000 ft. east of the present outpost G. W. Wickham No. 1. The Gilmour project topped the oil sand at 7190 ft., which, on a sea level basis, appears to place it in a higher structural position than the Wickham well. Casing was cemented on bottom at 7481 ft. and a production test is being made after gun-perforating from 7200 to 7288 ft.

Production Try Fails In Mission Wildcat

Tide Water Associated Oil Co. has abandoned Mission No. 1 in the Aliso Canyon Area at the west end of San Fernando Valley after making unsuccessful production tests of four separate intervals. First attempt at completion was made from the casing shoe at 8988 ft. to bottom at 9291 ft. where streaks of

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FOUR COMPANIES DEDICATED TO THE WINNING OF THE WAR

sand showing light cuts had been cored. Recovery from this horizon, believed roughly equivalent to the Porter No. 12 Zone at Aliso Canyon, was muddy water testing 600 grains of salt per gallon and a trace of oil and gas. During a swabbing trial the fluid level was lowered to 6500 ft. and casing pressure built up to a maximum of 425 lbs. The hole was then plugged 6850 ft. and casing perforated 3540-3550 ft. and 3620-3640 ft. The casing was swabbed dry in a few hours. Plugged to 3408 ft., the well was perforated from 3150 to 3225 ft., but again swabbing recovered only a small amount of muddy water and the project was abandoned. Mission No. 1 sought to extend Aliso Canyon production a mile east of present limits of the field.

In sec. 28,3n-16w west of Aliso Canyon, Tide Water Associated Oil Co. and Standard Oil Co. are coring ahead below 6151 ft. in their joint wildcat Sesnon No. 1. For the last several hundred feet the well has been drilling in shale streaked with oil sand and barren gray sand.

Shell Oil Co.'s Mission No. 2-1, most easterly well in the area, is drilling below 6850 ft. in formation running largely to shale.

Texas Co. Spuds La Mirada Well

McNally No. A-2, The Texas Co.'s latest attempt to find a new field near La Mirada Station west of West Coyote, was spudded on April 3rd and is drilling in sandy shale near the 1500 ft. level. The project is located in sec. 15,3s-11w between the Santa Fe Springs and West Coyote fields.

Axis Abandons Rowland Project

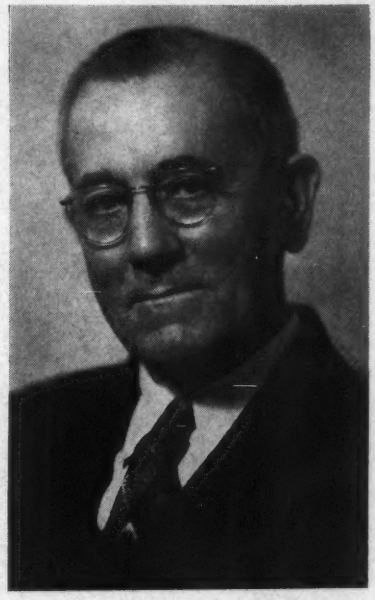
Finding only gray sand in cores from 2400 ft. to bottom at 2468 ft., Axis Petroleum Co. discontinued drilling W. R. Rowland Ranch No. 1 and converted it to a water well for the land owner. The project was a promising test for new Miocene production two and a half miles east of the newly found Turnbull Canyon field.

Samuel E. Rees Dies Suddenly March 26

Samuel E. Rees, who has been associated with Baker Oil Tools, Inc., since 1927, died suddenly March 26, shortly after having reported for work. Sam, as he was known throughout the California petroleum industry, had, for the past five years, served as secretary and treasurer for Baker Oil Tools, Inc. and also held the position of purchasing agent and credit manager.

Sam Rees was born near Kerrville, Texas, Oct. 4, 1892. He received his early education in Kerrville, and later attended A&M College. Following this, Sam taught school in Texas until his coming to California.

He located in Coalinga and represented the American Railway Express Co. there for a short time. Later he worked for A. P. May as clerk and bookkeeper in his general merchandise store. Following that he went into business for himself. After the advent of the automobile,



(Photo courtesy Associated News Service)
Samuel E. Rees

Mr. Rees sold his Hay, Grain, Wood and Coal establishment, and moved to a farm near Coalinga, where he remained until his association with Baker Oil Tools, Inc., in 1927.

Funeral services were held at the Wheat Halverson Mortuary in Huntington Park, and interment was at Inglewood Park Mausoleum, April 2.

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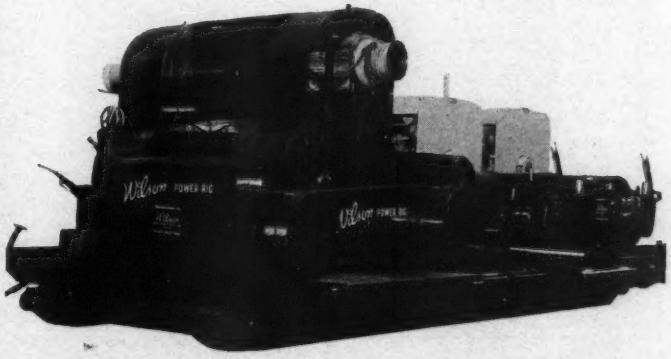

San Joaquin Valley

Shell Completes Raisin City Well

Shell Oil Co., Inc., completed Properties, Inc. No. 37-18 in sec. 18,15-18 of the Raisin City field flowing clean 25.5 gravity oil at a 375 bbl. rate through a 15/64 in. bean. Bottomed at 6078 ft. after finding the Kreyenhagen unpromising at 6055 ft., the well was plugged to 5266 ft. and finished with liner open from the shoe of 5½ in. casing at 5220 ft. to the plug. No other projects are presently active in the area.

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Amerada Testing Riverdale Project

Bottomed at 7612 ft. and with 7 in. casing cemented at 6775 ft. Amerada Pet. Corp. is gun perforating and testing lower Miocene sands in Jensen No. 54-26. Located in sec. 26,17-19, the well is offset development to the company's discovery well in the Riverdale field of Fresno county. In the same section the company is fishing drill pipe stuck while cleaning out Leal No. 34-26 for a water shut-off test on 5½ in. casing cemented at 6820 ft. The well had been bottomed at 6915 ft. where electric log showings prompted plugging back to 6875 ft. before making a production trial. Near the south quarter corner of the section Amerada is rigging up to drill Lawton No. 58-26.

General Petroleum Corp.'s outpost try, Community Eight No. 45-21, located northwest of production in sec. 21,17-19, was last reported drill-

SAN JOAQUIN VALLEY WILDCATS

Area	Well	No.	Section	Depth	Status
	Fresno County				
Burrel	Richfield Oil Corp., Schultz	1	27, 16-18		Location
Cantua Creek	Richfield Oil Corp. McDonald	1	32, 16-16	2149	Drilling
Guijarral Hills	Lytle, Robt. S., Opr., Well	68-28F	28, 20-16	8327	Drilling
Helm	Amerada Pet., Co., Clover	75–28	28, 16-17	8110	Drilling
Jacalitos Hills	Wilshire Annex Oil Co.	23–26E	26, 21-15	3638	Drilling
Kerman	Richfield Oil Corp., Ponte	1	30, 13-17	8273	Drilling
Mendota	Jergins Oil Co., Cheney Ranch	3	30, 14-13		Rigging up
Raisin City	Shell Oil Co., Inc., Prop., Inc.	37–18	18, 15-18	6078	Completed
	Shell Oil Co., Inc., S.A. & F.L.	22–19	19, 15-18		Location
Riverdale	Amerada Pet. Corp., Jensen	54–26	26, 17-19	7612	Testing
	Amerada Pet. Corp., Lawton	58–26	26, 17-19		Rigging up
	Amerada Pet. Corp., Leal	34–26	26, 17-19	6915	Testing
	General Pet. Corp., Comm 8	45–21	21, 17-19	6873	Drilling
	Kern County				
Belridge	Shell Oil Co., Inc., Williams	45–6	6, 28-20		Rigging up
Buttonwillow	The Texas Co., Root	9–C	9, 29-24	4940	Testing
	The Texas Co., KCL	24–C	24, 29-24	4950	Redrilling
Devils Den	Continental Oil Co., Mabury	1	25, 26-18	1992	Cleaning out
Edison	Getty, J. Paul, Mattson	1	6, 30-29	2579	Drilling
Grapevine	Richfield Oil Corp., KCL	3	36, 11-20	5968	Drilling
Kern River	Seaboard Oil Corp., Fuhrman	1	28, 28-28	5261	Rng. Elec. Log.
Kettleman–So.	Bristol Oil Corp., Hellman	1	2, 25-19	2174	Plugging
Midway	Western Minerals Co., U.S.A.	37–25	25, 11-23	1700	Abandoned
Mt. Poso	Alpha Oil Co., C. V. Elliott	1A	1, 27-28	1225	Drilling
	Signal Oil & Gas Co., Glide	23–1	22, 27-28		Rigging up
	Union Oil Co., Glide	2–7	7, 27-28	2582	Abandoned
Paloma	General Pet. Corp., Gallagher	61–33	33, 31-26	1814	Idle
	Western Gulf Oil Co., Symons	12–7	7, 32-27	11811	Testing
Richgrove	Bolling, R. S., Quinn	3	15, 25-27	2926	Idle
	Shell Oil Co., Curry	1	20, 25-26	7250	Abandoned
	The Termo Co., Parker	1	12, 25-27	843	Drilling
Shafter	Continental Oil Co., Neuman	1	36, 27-24	12788	Drilling
	General Pet. Corp., S.P.	51–15	15, 28-24	14252	Testing
Shale Hills	Tideland Oil Co., Grant Est.	1	4, 27-18	4113	Testing
	Kings County				
Pyramid Hills	Miesse & Emerich, Well	1	22, 24-17		Location
	Pacific O. & G. Dev. Corp., West Slope	2	20, 24-18		Location
	Tulare County				
Pixley	Continental Oil Co., Pixley Comm.	1	9, 23-25	7802	Drilling
Terra Bella	Stout, Geo. W., Stout	2	11 23-27	745	Idle
Trico	Trico Oil & Gas Co., Lee	1	17, 24-23		Rig
Tulare	Richfield O. Corp., Tulare Comm.	1-1	33, 19-24		Location

ing in hard shale at 7096 ft. No showings have been reported in this well and an electric log near 6700 ft. indicated that the project is running low on the structure.

Texaco Abandons Valley Gas Try

A mechanically imperfect hole coupled with meagre showings culminated in abandonment of The Texas Co.'s KCL No. 24-C, a gas try on sec. 24,29-24 at the easterly flank of the newly discovered Buttonwillow-Bowerbank gas producing area. Bottomed at 4950 ft. and plugged to 4780 ft. the well was tested in a 20 ft. interval above the plug and recovered only mud and salt water with no gas showing. Bridged to 3370 ft. attempts to test the hole at this stage failed due to the condition of the walls. An attempt to redrill to the upper sands failed due to caving hole and the well was abandoned. The company's northwesterly extension try, Root No. 9-C in section 9 of the township, is testing water shut-off on 5½ in. casing cemented at 4640 ft. after bottoming at 4940 ft.

Seaboard Abandons Kern River Deep Try

Seaboard Oil Corp.'s Fuhrman No. 1, deep test located at the northeasterly edge of the old Kern River field in sec. 28,28-28, is abandoned in granite at 5261 ft. after finding the basement at 5187 ft.

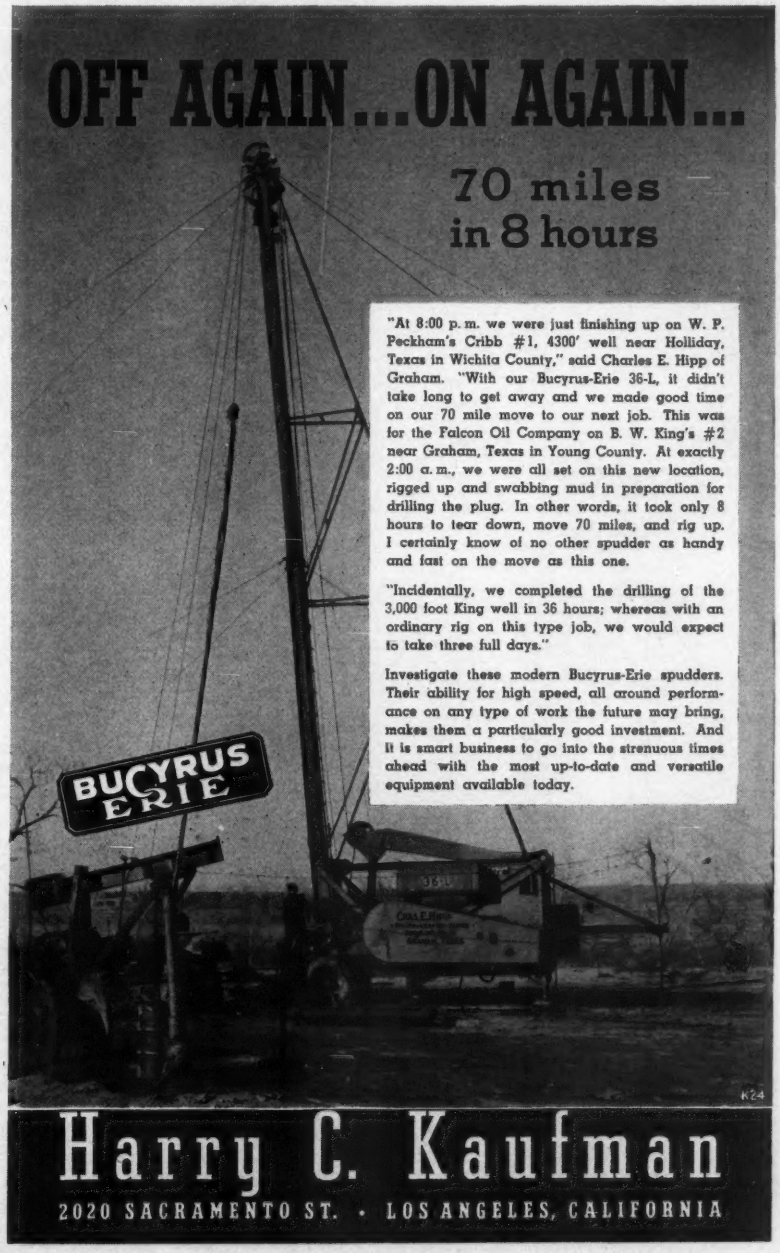
An electric log run to bottom failed to encourage testing a few oil stains found in the upper Vedder at 3878 ft. and in the lower Vedder at 4120 ft. Although these meagre showings graded into gray water sands it is conceded possible that a location up structure might encounter producible sands. Operators at present are considering such a test.

Richfield Prospecting Fresno County Areas

Richfield Oil Corp. is under way with three wildcats in promising sections of Fresno county. Latest to be added to the list is Schultz No. 1 in sec. 27,16-18 of the Burrel area. The proposed try is located two miles northwest of the General Petroleum Corp.'s Burrel No. 1, recently abandoned in the Cretaceous at 9400 ft. after finding no showings below 6300 ft. and recovering only mud and water from showings in the Continental Miocene.

Some 14 miles to the west in the Cantua Creek area the company is drilling McDonald Estate No. 1 on sec. 32,16-16. Located near the east quarter corner of the section, the well was last reported at 2149 ft.

Most northerly of the prospect holes is Ponte No. 1 on sec. 30,13-17 of the Kerman area. Last reported coring hard shale at 8273 ft. the well can properly be called a deep test since Cretaceous was found at 4770 ft. The Eocene section here was found to be only 153 ft. thick and offered no possibilities. Slight showings tested in the Temblor at 3660 ft. yielded traces of oil and a little gas.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Getty Drilling Edison Offset

Drilling in sec. 6,30-29, immediately west of his own discovery in section 5, J. Paul Getty's Mattson No. 1 is drilling near 2600 ft. after cementing a surface string at 503 ft. The well seeks the 20 gravity production which Getty discovered near the town of Edison in Portals Corp. No. 1. Bottomed at 4255 ft. after finding the sands at 4201 ft. the well initialed a 175 bbl. flowing rate but later resorted to the pump which maintains a substantial yield of good oil.

Robert New Elected President of Company

A program for expanding, exploration and production has been announced by Continental Development Corp., which last year drilled and now operates a number of wells in the Wilmington Field.

R. F. Ingold, chairman of the board, stated: "Now that Continental Development Corp. is planning a more ambitious program, the board of directors has chosen Robert V. New as president of the company. This was done in recognition of the outstanding development during 1941 of the corporation's Long Beach properties under Mr. New's direction as

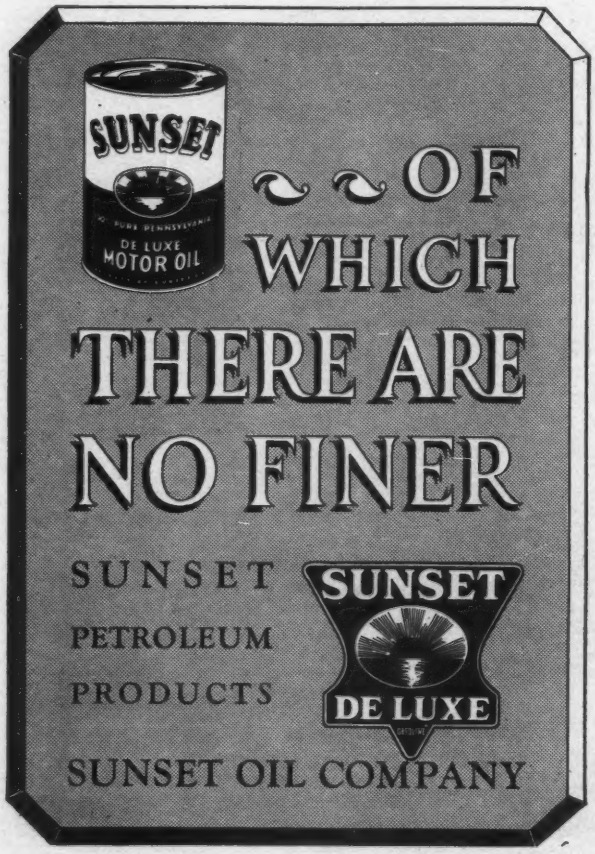
Robert V. New

vice-president and general manager. This development proved the efficiency of small-hole drilling for heavy oil and resulted in drilling costs about 40% below average for wells to the same zone in the field. The board felt that this outstanding service merited recognition. Mr. New will retain his position as vice-president of Continental Corp., also an oil producing company, and as a director of both corporations."

Mr. Ingold, who now occupies the newly created position of chairman of the board, is relieved of considerable demand on his time which he can now give to his other interests. Mr. Ingold is president of the Los Angeles Investment Co., California Cotton Oil Corp., and a director in a number of other industrial and financial organizations.

Standard to Drill Wildcat at Orcutt

Seeking a new heavy oil accumulation in the lower Sisquoc and the Monterey Chert Zones, Standard Oil Co. is preparing to drill an exploratory test half a mile north of the old Orcutt field and east of the town of Orcutt. At last reports grading was under way at the well site in the southeast corner of sec. 14,9n-34w. The company has approximately 2000 acres under lease between the Orcutt and Santa Maria Valley fields and is expected to drill several wells.



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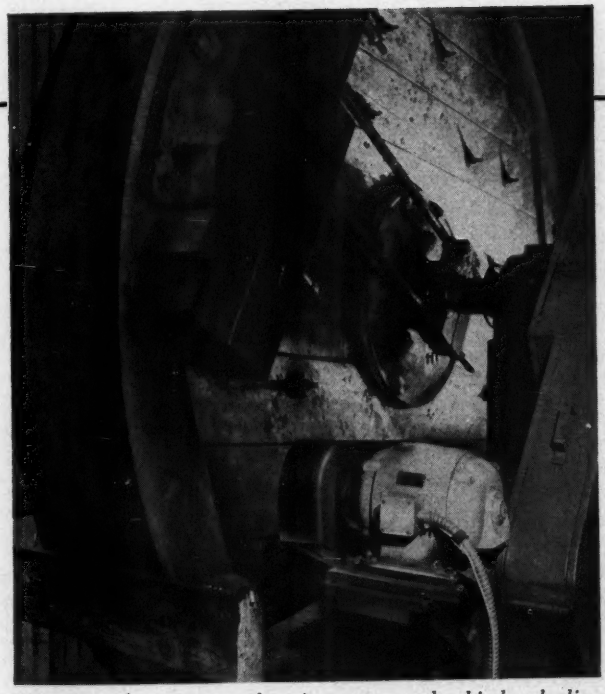

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Ojai Deep Test Delayed by Fish

Richfield Oil Corp.'s Ojai No. 44, deep test well in sec. 13,4n-22w, was delayed by frozen drill pipe with the bottom at 7717 ft. Formation at bottom is hard gray siltstone.

Continental Drills Ramona Anticline

With Holser No. 1 located in the northwest quarter of sec. 14,4n-18w, Continental Oil Co. is seeking a new field on Ramona Anticline near Piru in Ventura county. At last reports the well was drilling in hard formations near the 1500 ft. level.

In sec. 4 of the same township, Pacific Western Oil Co. is drilling Temescal No. 11 below 2700 ft. in hard shale showing 45° dips while to the north, in sec. 22,5n-18w, Delroy Petroleum Corp. is drilling Fisk Core Hole No. 3 at 775 ft.

Volunteer Files For Tar Creek Wells

Volunteer Petroleum Co. has filed notices to drill two new wells in the Tar Creek Area. Tar Creek No. 3 will be located in the northwest quarter of sec. 28-5n-19w and Phillips No. 2 will be in the northeast quarter of sec. 29.

H. A. Ivers ran an oil string to bottom at 1433 ft. in Kentuck No. 13½, sec. 1,4-20w, and is preparing to bail for a production test.

Gato Ridge Test Showing Oil

Republic Petroleum Co.'s Price No. 1, test well on the westerly flank of the Gato Ridge field, is spot coring in cherty brown shale below 4800 ft. with considerable oil in evidence below 4445 ft. The well is located in the northeast corner of the Price property in sec. 16,8n-32w.

Cat Canyon Wildcat Suspends Operations

O. C. Field & Wm. C. McDuffie, et al, suspended operations in Palmer-Stendel No. 13-1, located in sec. 13,9n-33w, after prolonged tests recovered only a small quantity of heavy tar. The hole was carried to 3435 ft. and was tested with 8 5/8 in. casing cemented at 2850 ft. and a perforated liner landed on bottom. Top of the Miocene was logged at 2700 ft.

Union Oil Co. is drilling Bell No. 14 near the 5000 ft. level in the new deep area west of the West Cat Canyon field. Located in sec. 27,9n-33w, the well adjoins the Standard Oil Co. Los Flores property where the deep Chert Zone production was discovered.

Union Oil Starts Santa Maria Well

Union Oil Co. is preparing to spud Bradley Lands No. 2-3 in sec. 36,10n-34w in the Santa Maria Valley field. Conforming to Order No. M-68, the well is located on the one well to forty acre basis.

In sec. 26 of the same township, Capital Co. is nearing completion in Gallison Fee No. 5 for which an exception to the spacing order was obtained.

In the old Santa Maria field, Union Oil Co. alternately drills (with cable tools) and bails in Graciosa No. 10 in sec. 36,9n-34w. The hole is bailed for several hours after each run with the tools in order to check the rate at which fluid enters the hole to determine the possible productivity of each stratum encountered.

Union Oil Plans Torrey Canyon Test

Union Oil Co. is planning to drill a deep test of its wholly-owned Torrey Canyon field in the easterly portion of Ventura county. Proposed location for the test is approximately 3750 ft. south and 2850 ft. east of the northwest corner of sec. 5,3n-18w. Object is to explore the Lower Sespe to about 6000 ft.

COASTAL COUNTIES WILDCATS

Area	Well	No.	Section	Depth	Status
Santa Barbara County					
Cat Canyon	Alphonzo E. Bell Corp., Gilmore	1	23, 9-33	6457	Idle
	O. C. Field & Wm. C. McDuffie et. al. Palmer-Stendel	13–1	13, 9-33	3435	Suspended
Casmalia	Dolly Adams Oil Co., Morganti	2	13, 9-35	1670	Idle
Lompoc	Alphonzo E. Bell Corp., Lompoc	6	28, 8-34		Graded roads
	Fickert Oil Co., Ltd., Well	1	8, 7-33		Rig
Santa Maria	Roy Lee, Trustee, T.G.	1	33, 10-33	3503	Idle
Ventura County					
Bardsdale	Hopland Oil Co., Well	1	1, 3-19	4634	Idle
	Santa Marino Oil Co., Elkins	1	7, 3-19		Grade
	Ventura Southern Oil Co.	G–1	19, 3-19	3735	Drilling
Conejo	Sycamore Oil Co., Boylan	1	23, 1-20	1700	Rigging up
Ojai	Coates, Spencer D., Pirie	5	7, 4-22	490	Drilling
	Kelalee Pet. Co., Harvey	1	8, 4-21		Rig
	Richfield Oil Corp., Ojai	44	13, 4-22	7717	Drilling
Oxnard	Signal Pet. Co., Well	1	36, 1-22		Location
Piru	Continental Oil Co., Holser	1	14, 4-18	1158	Drilling
	Delroy Pet. Corp., Fisk Core Hole	1	22, 5-18	760	Drilling
	Pacific Western Oil Co., Temescal	11	4, 4-18	2700	Drilling
Sespe	Alford Drlg. & Expl. Co.	1	18, 4-19	2581	Idle
	Highland Drilling Co., Cosby	1	14, 4-19	1996	Idle
	Ivers, H. A., Kentuck	13½	1, 4-20	1433	Bailing
	Volunteer Pet. Co., Tar Creek	3	28, 5-19		Location
	Volunteer Pet. Co., Phillips	2	29, 5-19		Location
Timber Canyon	Crude Oils, Inc., West	1	19, 4-20	958	Idle
	Denison, A. T., Denison	1	13, 4-21	1450	Drilling
	Henderson-Ortez Oil Co., O'Leary	1	29, 4-20		Rig

NORTHERN COUNTIES WILDCATS

County	Well	No.	Section	Depth	Status
Colusa	Pacific National Pet Corp.	1	17, 17n-4w	1400	Idle
Madera	Blake, T. E., Chuck	1	28, 10s-17e		Rig
Merced	T.W.A.O.-Seaboard Oil Co., Turlock Ld. Co.	37–18	18, 6s-11e		Grading
Monterey	Loma Grande Oil Co., Corey	1	23, 24s-10e	4004	Idle
San Joaquin	Westates Pet. Corp., Spence	1	22, 1s-7e	5230	Drilling
	Standard Oil Co., Blewett Comm.	3	23, 3s-6e		Rig
Sonoma	Standard Oil Co., Petaluma	1	14, 5n-7w	1035	Drilling
Stanislaus	Don Pedro Oil Co., Newman	1	9, 6s-9e	4077	Idle
Sutter	Buttes Oilfields, Inc., Buttes	7	3, 15n-1e	5250	Shut-in
	Buttes Oilfields, Inc., Buttes	8	28, 16n-2e	5560	Idle
Yuba	Wright, L. G., Cox	1	18, 14n-5e	1805	Idle

Formation of Hydrocarbon Hydrates

(Concluded)

It is of considerable interest to operators to have some knowledge of possible means for eliminating hydrates if they should form in lines or plant equipment, and most important it is necessary to know how to prevent their formation under all conditions of operation. Several writers have devoted papers to this phase of the subject in the past (19), (20), (21), (22), (23), (24), (25). We may consider the problem of hydrate control to be divided into two categories. First, there is the problem of eliminating hydrates which may have already formed and which must be removed in order to restore the equipment to proper operating conditions. Such situations usually arise because gas is handled at high pressures and relatively low temperatures without preliminary dehydration. From the curves of Fig. 2, it is obvious that one simple method for removal of hydrates is to lower the pressure in the system so that it is below the equilibrium point and the hydrate will decompose into hydrocarbon gas and water. However, this is not always possible since frequently it is necessary to maintain pressure above the equilibrium point for other reasons. Furthermore, it is sometimes possible to lower the pressure to accommodate a given temperature condition at one point and find that the temperature is low enough at another point in the system so that the new pressure is sufficient to produce hydrates at that point. Another obvious expedient would be to raise the temperature at the point where hydrates exist. This has been attempted in some instances by building fires around lines to raise the temperature to the point where hydrates can no longer exist. This is an unsatisfactory procedure because the entire system can never be raised sufficiently in temperature to preclude the re-formation of hydrates at another point beyond where the decomposition has been effected.

TABLE 2
TEMPERATURES AND PRESSURES FOR FORMATION OF NATURAL GAS HYDRATES

Gas B		Gas C		Gas D	
Temp., °F.	Pressure, lb./sq. in. abs.	Temp., °F.	Pressure, lb./sq. in. abs.	Temp., °F.	Pressure, lb./sq. in. abs.
		1st Series		1st Series	
42.2	182	40.2	232	38.5	175
49.5	279	51.3	492	47.2	317
60.0	598	60.8	1010	53.2	510
66.2	1010	66.0	1523	60.0	790
69.6	1404	68.3	2049	64.5	1190
71.5	1779			68.1	1740
73.3	2443	2nd Series		2nd Series	
75.0	3000	42.7	279	60.8	895
77.3	3963	47.6	384	66.0	1350
		56.4	699	69.4	2040
		62.8	1180	71.3	2640
		64.5	1375	74.7	3850
		68.3	1999	73.0	3270
		71.3	2939		
		70.0	2489		
		74.3	3989	Data by Wilson, Carson and Katz.	
		72.3	3335		

Furthermore, this practice is dangerous for reasons which are obvious. It is clear that removal of liquid water from equipment does not obviate the possibility of hydrate formation since gas which is saturated with water vapor can deposit hydrates in at least small amounts under proper temperature and pressure conditions. Removal of the liquid water can merely reduce the total amount of hydrate which might eventually be formed. It has been found that when equipment has become plugged with accumulations of hydrates it is possible to cause their decomposition by the introduction of substances which have a lowering effect upon the decomposition temperature. For example, methyl, ethyl or propyl alcohols may be added in very small amounts to the gas line or other equipment and the solid hydrate will be found to decompose into hydrocarbon gas and liquid water. It has also been demonstrated that gaseous ammonia will serve the same purpose (24), (25). However, the use of ammonia gas under conditions where carbon dioxide is present may result in situations which are even worse than the development of the hydrate plug. Ammonia can form solid ammonium carbonate with any CO_2 which is present and this will accumulate at points in the system where deposition is possible, producing a plug which is not readily removed. It is not possible to decompose this compound by depressuring or increasing temperature in a manner similar to that which may be used with hydrates. It has been reported that fuel oils have been used to decompose hydrate plugs in pipe lines but it is believed that the value of this material for such a purpose is extremely doubtful. Probably the only effect which might be produced is one of purely physical removal of the solid substance.

So far we have discussed only methods alleviating a condition where hydrates already exist. It is of more importance to arrange a gas transmission or processing system so that hydrates cannot be formed under any conditions of operation. In order to accomplish this, it is necessary to dehydrate the gas so that it will never become saturated with water vapor under any temperature and pressure conditions which it may encounter throughout the system. It is not necessary that all the water be removed from the gas so long as the amount remaining is insufficient to bring the gas to its dew point with respect to water at the lowest temperature to be found in the system. Methods of

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dehydration which are well known may include such processes as dew point lowering by refrigeration; water removal by adsorption in glycol dehydration plants; water removal by contact with solid dehydrating agents such as activated alumina or silica gel; dew point lowering by contacting the gas with calcium chloride or sodium chloride brines; or similar operations. It is also possible to take advantage of the decomposition temperature lowering effect of the chemical agents mentioned above by adding them to the gas flowing in the equipment before hydrates are formed. However, it is now general practice to preclude the possibility of forming hydrates by using dehydration methods, and these should always be included in systems where hydrate formation is anticipated. It is obvious that the method of dehydration to be selected will depend upon local conditions. In areas where atmospheric temperatures do not fall to low levels, it will not be necessary to remove as much water as may be the case in extremely cold climates. Of course, pressure conditions throughout the installation will also be a determining factor in selecting the proper process for maintaining a sufficiently low dew point with respect to water.

It is to be expected that as higher pressures are utilized in plant operations and field installations, such as are now being encountered in repressuring and recycling systems, the problem of hydrate formation will become more common and more troublesome. This is to be expected because at pressures in the neighborhood of 2000 to 3000 p.s.i. the equilibrium temperature may easily be as high as 70 ° F. In many localities, atmospheric conditions are such as to readily provide necessary removal of heat to form hydrates in considerable quantities if the required amount of water is present in the system.

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Oil Men's Calendar

Calif. Natural Gasoline Association. Los Angeles Chapter—Meets 1st Thursday Each Month, Barker Bros. Bldg., Los Angeles—Dinner at 6:00 (Optional). Taft Chapter—Meets Third Thursday Each Month.

American Society of Mechanical Engineers—Los Angeles Section—Meets 2nd Thursday Each Month—Barker Bros. Bldg., Los Angeles. Dinner at 6:30 (Optional).